

SOIL SURVEY OF

Buena Vista County, Iowa



This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1968-71. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service, the Iowa State University Agriculture and Home Economics Experiment Station and Cooperative Extension Service, and the State of Iowa Department of Soil Conservation. It is part of the technical assistance furnished to the Buena Vista County Soil Conservation District. Funds appropriated by Buena Vista County and by the State of Iowa were used to defray part of the cost of this survey.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for farming, industry, or recreation.

Locating Soils

All the soils of Buena Vista County are shown on the detailed map at the back of this publication. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with a number shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas

lucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and the environmental planting groups.

Foresters and others can refer to the section "Use of the Soils for Environmental Plantings," where the soils of the county are grouped accord-

Contents

	Page		Page
How this survey was made.....	1	Millington series.....	26
General soil map.....	2	C458—Millington loam, channeled, 0 to 2 percent slopes.....	26
1. Clarion-Nicollet-Canisteo association.....	2	Nicollet series.....	26
2. Sac-Primghar-Galva association.....	4	55—Nicollet loam, 1 to 3 percent slopes.....	28
3. Clarion-Drummond association.....	5	951—Nicollet silty clay loam, 1 to 3 percent slopes.....	28

	Page
General nature of the county	88
History	88
Relief and drainage	88
Climate	89
Farming	89

	Page
Literature cited	91
Glossary	91
Guide to mapping units	Following 92

Summary of Tables

	Page
Descriptions of the Soils	
Approximate acreage and proportionate extent of the soils (Table 1)	9
Use and Management of the Soils	
Predicted average yields per acre of principal crops under a high level of management	
(Table 2)	51
Environmental planting groups of soils and suitable trees or shrubs (Table 3)	54
Estimates of soil properties significant to engineering (Table 4)	58
Interpretations of engineering properties of the soils (Table 5)	62
Formation and Classification of the Soils	
Soil series classified according to the current system of classification (Table 6)	88
General Nature of the County	
Temperature and precipitation data (Table 7)	90
Probabilities of last freezing temperatures in spring and first in fall (Table 8)	90

This page intentionally left blank.

SOIL SURVEY OF BUENA VISTA COUNTY IOWA



ences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Galva silty clay loam, 2 to 5 percent slopes, is one of several phases within the Galva series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs

of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive proportional pattern of soils. It generally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but



Figure 3.—Typical area in the Clarion-Nicollet-Canisteo soil association.

Canisteo soils are nearly level. They are on low-lying flats on the glacial till plain. Canisteo soils formed in loamy, calcareous glacial sediment or glacial till. They are calcareous and poorly drained.

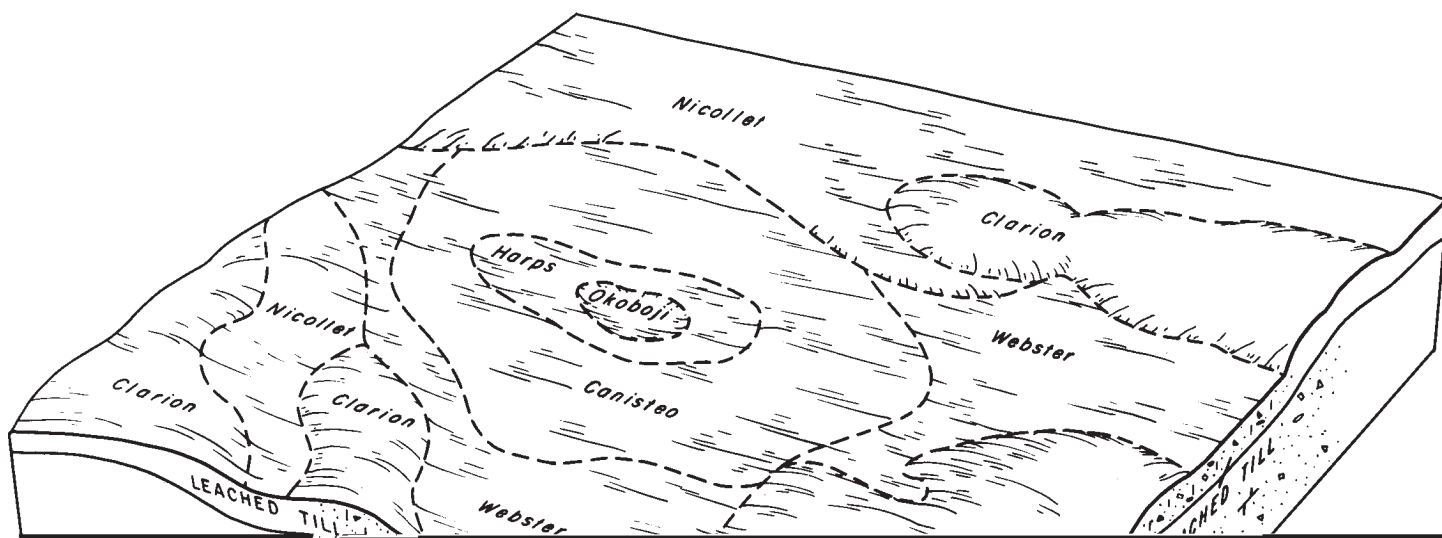
Webster soils are nearly level. They are on low-lying flats on the glacial till plain. Webster soils formed in loamy glacial sediment or glacial till. They are poorly drained.

The minor soils in this association are mainly in the Biscay, Blue Earth, Collinwood, Colo, Cylinder, Harps, Lan-

yon, Okoboji, Salida, Spillville, Storden, Talcot, Wacousta, Wadena, and Waldorf series.

The depressional, very poorly drained Blue Earth, Lan- yon, and Wacousta soils occupy the shallow glacial lake basins; the depressional, very poorly drained Okoboji soils occupy the smaller landlocked depressions; and the nearly level, poorly drained Harps soils generally occupy narrow rims around the landlocked depressions and larger glacial lake basins. The nearly level, poorly drained Colo soils and the nearly level, somewhat poorly drained Spillville soils are adjacent to the drainageways and stream valleys on sloping, concave foot slopes.

Areas of fine-textured, poorly drained Waldorf soils and fine-textured, somewhat poorly drained Collinwood soils are closely intermingled with areas of Webster and Nicollet soils; areas of well-drained and somewhat poorly drained glacial outwash soils of the Wadena and Cylinder series that have sand and gravel at a depth of 24 to 40 inches are intermingled with areas of Clarion and Nicollet soils; areas of very poorly drained and poorly drained glacial outwash soils of the Talcot and Biscay series that have sand and gravel at a depth of 24 to 40 inches are intermingled with areas of Canisteo and Webster soils; and areas of moderately sloping or strongly sloping, calcareous, loamy Storden soils and moderately sloping or strongly sloping, shallow, moderately coarse textured Salida soils are intermingled with areas of Clarion soils.



Corn, soybeans, small grain, and alfalfa grow well in the nearly level and gently sloping soils of this association, but the moderately sloping soils are only moderately well suited to row crops. The soils in this association have moderate or moderately slow permeability and high available water capacity. The content of organic matter is high in the surface layer in the nearly level soils, moderate or high in the gently sloping soils, and moderately low or moderate in the moderately sloping soils. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium in the surface layer generally ranges from very low to medium, and the content of available potassium in the subsoil generally is very low or low. Clarion, Nicollet, and Webster soils are slightly acid or neutral in the surface layer, and Canisteo soils are mildly alkaline or moderately alkaline in this layer. The major concerns of management for cropland are adequate erosion control on the gently sloping and moderately sloping soils and adequate drainage on the nearly level, poorly drained soils.

Nearly all areas of this association are used for cultivated crops, but a few areas of strongly sloping soils, a few undrained areas that are wet, and a few areas of droughty soils are used for permanent pasture. The main enterprises are growing cash crops and feeding hogs and beef cattle. The soils of the Clarion-Nicollet-Canisteo association are among the most productive in the county (fig. 5).

2. Sac-Primghar-Galva Association

Well-drained and somewhat poorly drained, moderately fine textured, nearly level to moderately sloping soils on loess-mantled uplands

The soils of this association are nearly level to moderately sloping silty clay loams. They are on a loess-mantled upland



Figure 6.—Typical aerial view in the Sac-Primghar-Galva soil association. Sac silty clay loam, loam substratum, is in the foreground.

county. It is about 35 percent Sac soils, 30 percent Primghar soils, 20 percent Galva soils, 9 percent Marcus soils, and 6 percent minor soils.

Sac soils are gently sloping and moderately sloping. The gently sloping soils generally are on long convex slopes, and the moderately sloping soils are on shorter convex slopes adjacent to the larger drainageways and stream valleys. Sac soils formed in thin loess that is generally 24 to 40 inches deep, and in the underlying glacial till. They are well drained and have a substratum of loam.

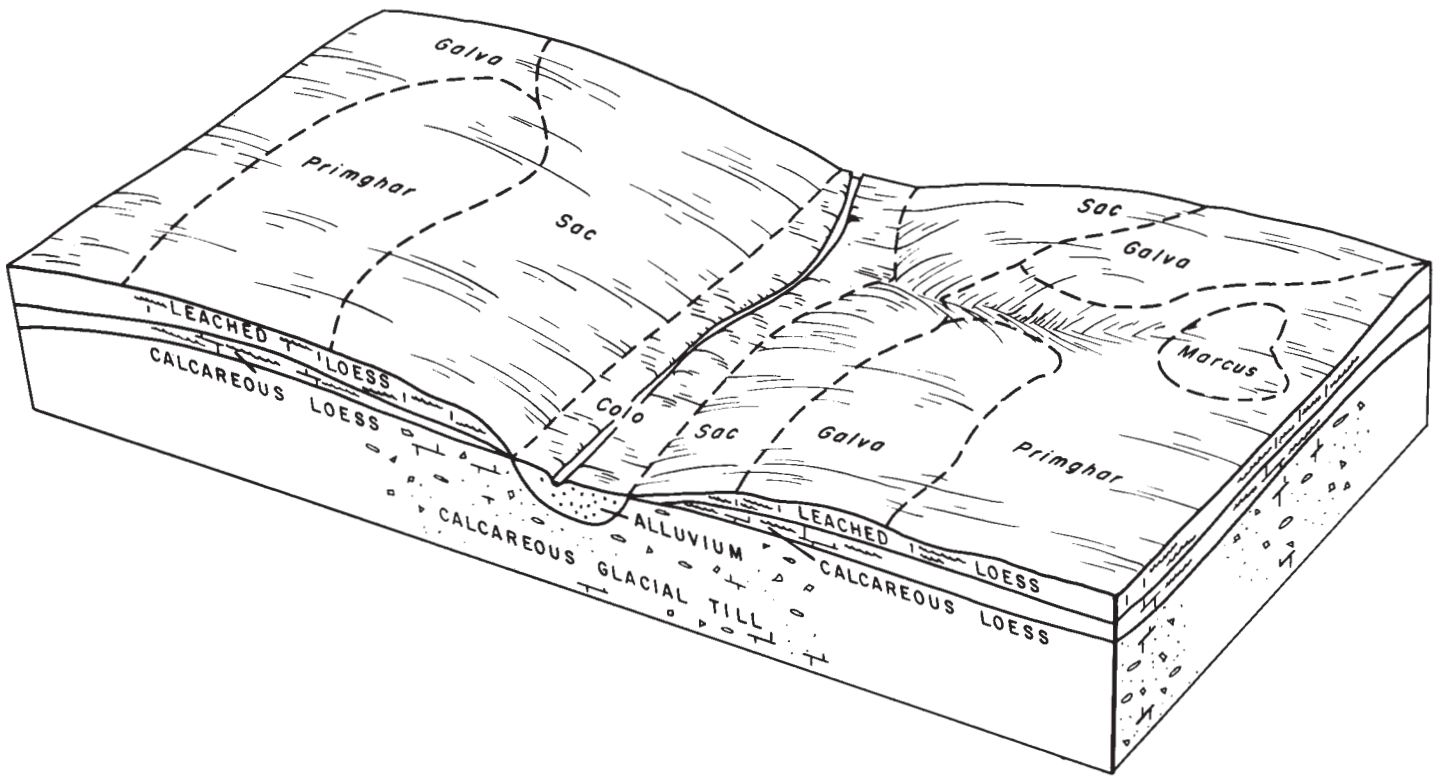


Figure 7.—Relationship of slope and parent material to the soils of the Sac-Primghar-Galva association.

moderately slow permeability and high available water capacity. The content of organic matter is high in the surface layer in the nearly level soils, moderate or high in the gently sloping soils, and moderately low or moderate in the moderately sloping soils. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium in the surface layer generally is medium or high, and the content of available potassium in the subsoil generally is very low or low. Unless they are limed, the dominant soils in this association are acid in the surface layer. The major

This association occupies about 6 percent of the county. It is about 32 percent Galva soils, 30 percent Sac soils, 25 percent Primghar soils, and 13 percent minor soils.

Galva soils are gently sloping and moderately sloping. The gently sloping soils generally are on long convex slopes, and the moderately sloping soils are on moderately long convex slopes adjacent to the larger drainageways and stream valleys. These Galva soils formed in loess that is more than 40 inches thick. They are well drained.

Sac soils are gently sloping and moderately sloping. The gently sloping Sac soils generally are on long convex slopes, and the moderately sloping ones are on moderately long

to row crops. These soils have moderate or moderately slow permeability in Colo and Spillville soils and very low, low, or medium in
permeability and high available water capacity. The content of available potassium in the under-
Colo soils. The content of available potassium in the under-

Waldorf soils are nearly level. They generally are on





Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are



TABLE 1.—*Approximate acreage and proportionate extent of the soils*

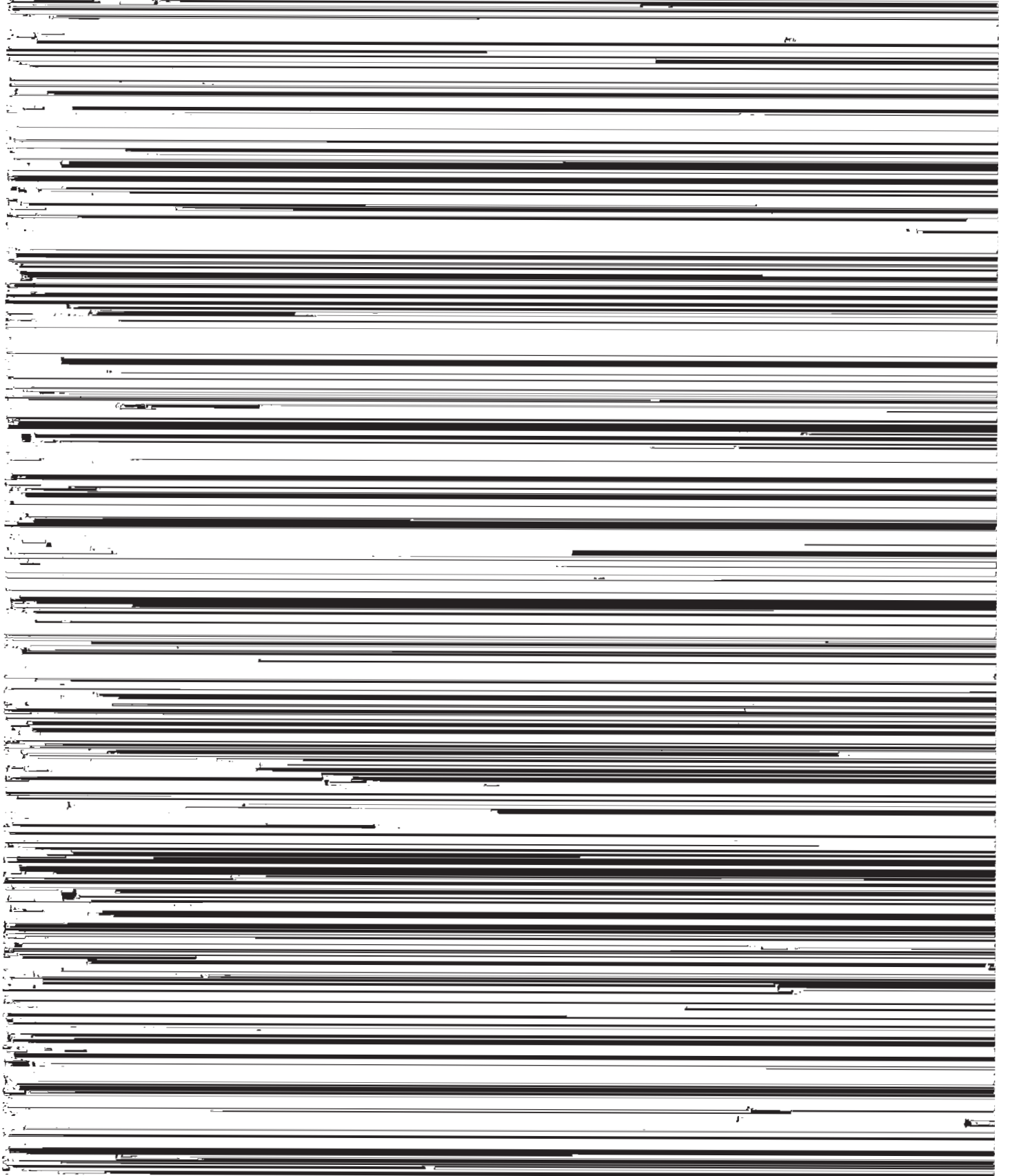
This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

TABLE 1.—*Approximate acreage and proportionate extent of the soils—Continued*

Mapping unit	Acres	Percent
Marsh	105	(1)
Millington loam, channeled, 0 to 2 percent slopes	600	.2
Nicollet loam, 1 to 3 percent slopes	48,225	13.1
Nicollet silty clay loam, 1 to 3 percent slopes	1,530	.4
Okoboji silty clay loam, 0 to 1 percent slopes	8,460	2.3
Primghar silty clay loam, 0 to 2 percent slopes	19,300	5.3
Primghar silty clay loam, 2 to 4 percent slopes	12,420	3.4
Rolfe silt loam, 0 to 1 percent slopes	130	(1)
Sac silty clay loam, loam substratum, 2 to 5 percent slopes	30,090	8.2
Sac silty clay loam, loam substratum, 5 to 9 percent slopes, moderately eroded	2,295	.7
Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes	3,530	1.0
Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes, moderately eroded	1,645	.4
Salida gravelly sandy loam, 5 to 9 percent slopes	340	.1
Salida gravelly sandy loam, 9 to 14 percent slopes	260	.1
Spicer silty clay loam, 0 to 2 percent slopes	360	.1
Spillville loam, 0 to 2 percent slopes	825	.2
Spillville loam, 2 to 5 percent slopes	1,780	.5
Storden loam, 5 to 9 percent slopes	1,495	.4
Storden loam, 9 to 14 percent slopes	1,855	.5
Storden loam, 14 to 18 percent slopes	950	.3
Storden loam, 18 to 25 percent slopes	1,405	.4
Storden loam, 25 to 40 percent slopes	2,505	.7
Talcot clay loam, deep, 0 to 2 percent slopes	2,190	.6
Talcot clay loam, moderately deep, 0 to 2 percent slopes	255	.1

Biscay Series

Thickness of the solum ranges from 32 to 40 inches. Depth to sand



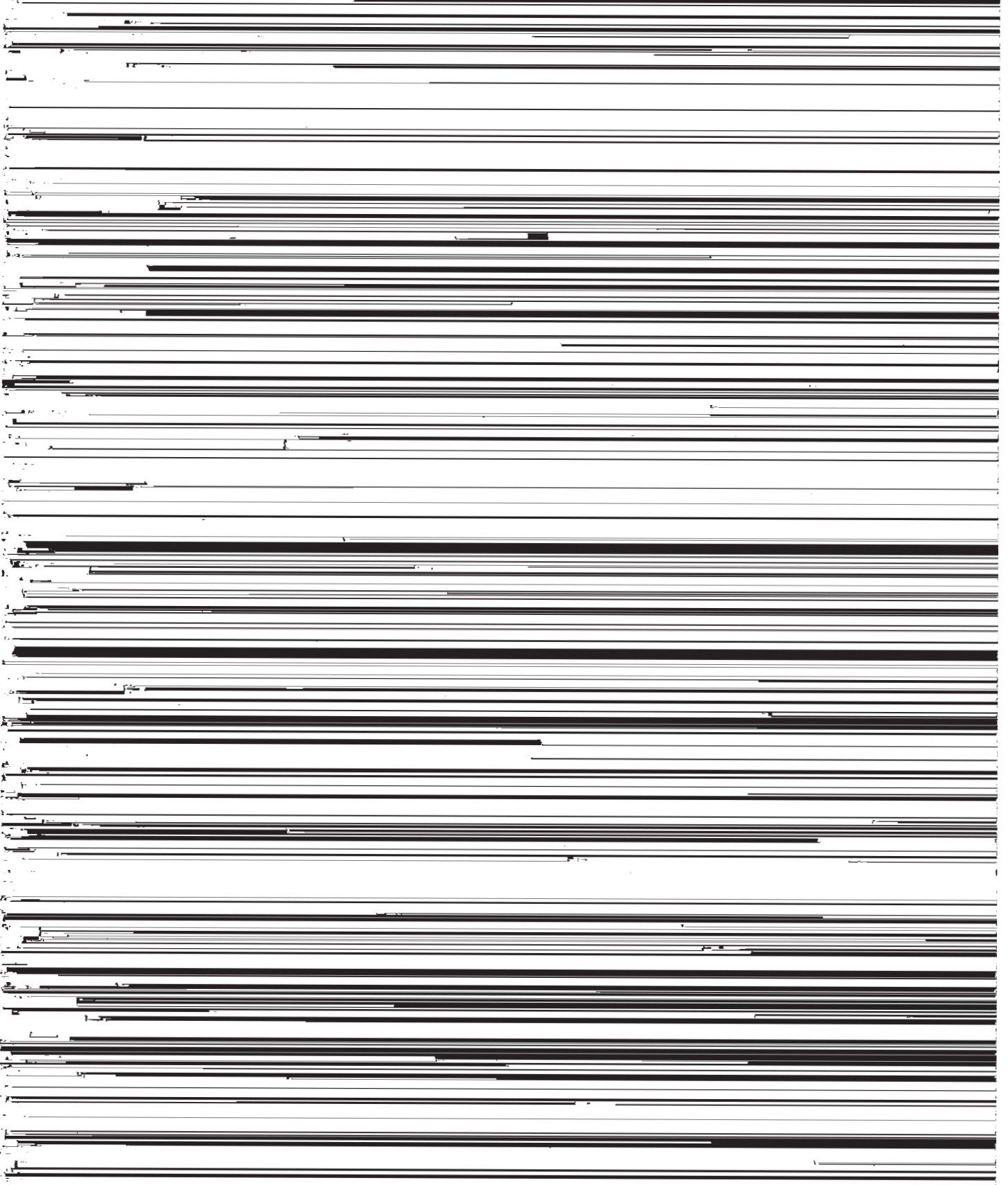
medium, granular; friable; common roots; few fine fragments of snail shells; slight effervescence; moderately alkaline; clear, smooth boundary.

A13—16 to 22 inches, black (N 2/0) silty clay loam; weak, fine and medium subangular blocky structure; friable; common roots;

and in the underlying material. The content of available potassium ranges from very low to low in the surface layer and is very low or low in the underlying material. Reaction is moderately alkaline in the surface layer.

black clay loam in the middle part, and very dark gray clay

The B2g horizon ranges from dark gray (5Y 4/1) to olive gray (5Y



B22—21 to 32 inches, brown (10YR 4/3) loam; thin, discontinuous very dark grayish brown (10YR 3/2) coatings on peds; weak, fine and medium, subangular blocky structure; friable; common roots; common fine tubular pores; common small pebbles; neutral; clear, wavy boundary.

C1—32 to 40 inches, yellowish-brown (10YR 5/4) light clay loam; common fine distinct mottles of grayish brown (10YR 5/2),

generally ranges from 24 to 40 inches. The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is dominantly loam, but in places it is silty clay loam, sandy loam, or light clay loam. Unless eroded, the A horizon is 10 to 16 inches thick. Reaction in the A horizon is lightly acid or neutral.

The B horizon is loam or light clay loam and is 8 to 30 inches thick. The B1 horizon, if present, is very dark brown (10YR 3/3) or brown



This soil has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam or clay loam and the subsoil is clay loam. It formed in sediment derived from glacial till or partly in the sediment and partly in the underlying glacial till. Included in mapping are small areas of Nicollet, Collinwood, and Storden soils.

Most areas of this soil are cultivated. Where erosion is controlled, the soil is well suited to row crops. It is moderately susceptible to erosion. The content of organic matter in the surface layer is moderate or high. Capability unit IIe-1; environmental planting group 1.

Collinwood Series

The Collinwood series consists of somewhat poorly drained soils that have convex slopes. These soils are on the undulating Wisconsin (Carv) till plain. They formed in fine-

(2.5Y 4/2) and yellowish brown (10YR 5/6); thin, discontinuous coatings of very dark gray (10YR 3/1) on peds in upper part; weak, fine and medium, subangular blocky structure; firm; few roots; few fine tubular pores; few fine segregations and concretions of yellowish-brown (10YR 5/6) iron and manganese oxides; common fine and medium segregations and concretions of calcium carbonate; slight effervescence; moderately alkaline; gradual, smooth boundary.

C1—37 to 48 inches, grayish-brown (2.5Y 5/2) silty clay; common, fine and medium, faint and distinct mottles of light brownish gray (2.5Y 4/2), and yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; firm; few roots; few fine tubular pores; common fine segregations and concretions of yellowish-brown (10YR 5/6) iron and manganese oxides; common fine and medium segregations and concretions of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2—48 to 56 inches, mixed yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) silty clay; common, fine and medium, faint and distinct mottles of yellowish brown (10YR 5/6) and gray (10YR 6/1); weak, medium, subangular blocky structure; firm, few roots; few fine tubular pores; common fine segrega-

high. Capability unit IIe-4; environmental planting group 2.

384C—Collinwood silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is on convex side slopes on uplands. Areas of this soil are long and narrow or irregular in shape and range from 4 to 16 or more acres in size.

This soil has a profile similar to the one described as representative of the series, but in most places the surface layer is a few inches thinner. Included in mapping are small areas of Clarion soils and small areas of Collinwood soils that have slopes of more than 9 percent.

Most areas of this soil are used for cultivated crops and pasture. The soil is moderately well suited to row crops. It is highly susceptible to erosion, and the clayey texture hinders the growth of roots. The content of organic matter in the surface layer is moderate. Capability unit IIIe-1:

Thickness of the solum ranges from 36 to 56 inches. The A horizon is black (N 2/0 or 10YR 2/1) silty clay loam or heavy silt loam. It is 36 to 50 inches thick. Reaction in the A horizon is neutral or slightly acid. Some profiles have weak structural B horizons or AC horizons.

The C horizon ranges from very dark gray (10YR 3/1) to gray (5Y 5/1) or olive gray (5Y 5/2). It generally is silty clay loam. In places, however, it is clay loam, and in some places below a depth of 48 inches texture ranges from sandy loam to sand. Reaction in the C horizon ranges from neutral to moderately alkaline.

Colo soils, like the associated Calco and Afton soils, are poorly drained. Unlike Calco soils, Colo soils have a noncalcareous solum. Colo soils have a thicker A horizon than that of Afton soils.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level soil is on bottom lands. Areas of this soil are long and narrow in shape and generally range from 20 to 80 or more acres in size.

natural levees and the Colo soil is in the low-lying swales.

About 60 percent of the mapped areas is Colo silty clay loam, and about 40 percent is Spillville loam. The individual areas are long and somewhat narrow in shape and range from 20 to 500 or more acres in size.

The Colo and Spillville soils have profiles similar to those described as representative of their respective series, but the surface layer is not as thick and the underlying material is mildly alkaline or moderately alkaline.

Included with this complex in mapping are a few areas of soils that are calcareous in the lower part of the surface layer. Several inches of sediment have recently been deposited on the surface in places.

Most areas of this complex are in pasture or in trees or brush. Much of the area adjacent to the Little Sioux River is covered with scrub timber. This complex (fig. 12) is poorly suited to row crops. It is susceptible to frequent flooding. Capability unit Vw-1; environmental planting group 2.

Cylinder Series

The Cylinder series consists of somewhat poorly drained soils in glacial outwash areas and on stream terraces. These soils formed in loamy glacial outwash underlain by sand and

sand and gravel and rapid or very rapid permeability within it. They have moderate or low available water capacity. The content of organic matter in the surface layer is moderate or high. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil, and content of available potassium is low or medium in the surface layer and very low or low in the subsoil. Reaction generally is slightly acid or neutral in the surface layer.

Cylinder soils are used mainly for cultivated crops. The major limitation in cultivated areas is the limited available water capacity.

Representative profile of Cylinder loam, moderately deep, 0 to 2 percent slopes, in a cultivated field 500 feet north and 1,020 feet east of the southwest corner of NE1/4 sec. 34, T. 91 N., R. 37 W.:

Ap—0 to 9 inches, black (10YR 2/1) loams; weak, fine and medium, granular structure; friable; many roots; common very fine and fine tubular pores; common small pebbles; slightly acid; abrupt, smooth boundary.

A12—9 to 16 inches, very dark gray (10YR 3/1) loam; common fine peds of very dark grayish brown (10YR 3/2); discontinuous coatings of black (10YR 2/1) on peds; weak, fine and medium, subangular blocky structure parting to weak, fine and medium, granular; friable; common roots; common very fine and fine tubular pores; common small pebbles; neutral; gradual, smooth boundary.

common, fine and medium, faint mottles of light olive brown (2.5Y 5/4); thin, discontinuous coatings of very dark grayish brown (2.5Y 3/2) and very dark gray (10YR 3/1) on peds; weak, fine and medium, subangular blocky structure; friable; few roots; common fine and medium segregations and concretions of iron and manganese oxides; common small and medium pebbles; neutral; clear, wavy boundary.

IIC1—30 to 56 inches, mixed light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) sand and gravel; common, fine and medium, distinct mottles of yellowish brown (10YR 5/6);

Dickinson Series

The Dickinson series consists of somewhat excessively drained soils on uplands and on stream terraces. These soils formed in moderately coarse textured and coarse textured glacial drift or outwash and alluvial sediment reworked or redeposited by the wind. The native vegetation was prairie grasses. Slopes range from 2 to 5 percent.

The C1 horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6). It is loamy fine sand, loamy sand, fine sand, or sand. Reaction in the C1 horizon is slightly acid or neutral.

Dickinson soils are associated with Clarion and Estherville soils. They contain more sand than Clarion soils. Dickinson soils have a thicker solum than Estherville soils. Unlike Estherville soils, they have no gravel and coarse sand in the C1 horizon.

175B—Dickinson fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on sandy convex ridges on glacial till uplands and on stream terraces. Areas of this soil are irregular in shape and range from 4 to 10 or more acres in size.

Included with this soil in mapping are areas of soils that contain coarse sand and gravel. Also included are small areas of Dickinson soils that have slopes of less than 2 percent.

Most areas of this soil are used for cultivated crops and pasture. The soil is moderately well suited to row crops. It is susceptible to erosion and has low available water capacity. The content of organic matter in the surface layer is moderate. Capability unit IIIe-4; environmental planting group 1.

coatings on peds; weak, fine, subangular blocky structure; friable; common roots; common very fine and fine tubular pores; few fine segregations of iron and manganese oxides; slightly acid; gradual, smooth boundary.

B21—33 to 38 inches, dark grayish-brown (10YR 4/2) silty clay loam; common, medium, faint mottles of brown (10YR 4/3); thin, discontinuous coatings of very dark grayish brown (10YR 3/2) and black (10YR 2/1) on peds; weak, fine and medium, subangular blocky structure; friable; common roots; common very fine and fine tubular pores; common fine segregations and concretions of iron and manganese oxides; neutral; gradual, smooth boundary.

B22—38 to 43 inches, olive-brown (2.5Y 4/3) silty clay loam; coatings of dark grayish brown (2.5Y 4/2) and very dark grayish brown (10YR 3/2) on peds; weak, medium, prismatic structure parting to weak, fine and medium, subangular blocky; friable; few roots common very fine and fine tubular pores; common fine segregations and concretions of iron and manganese oxides; neutral; gradual, smooth boundary.

B3—43 to 52 inches, mixed grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/4 and 10YR 5/6) silty clay loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few roots; common very fine and fine tubular pores; many fine segregations and concretions of iron and manganese oxides; neutral; gradual, smooth boundary.

C1—52 to 77 inches, grayish-brown (2.5Y 5/2) silt loam; common, medium, distinct mottles of yellowish brown (10YR 5/4 and

In a representative profile the surface layer is black sandy loam about 13 inches thick. The subsoil of very friable sandy loam extends to a depth of 19 inches. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum is dark yellowish-brown gravelly sand to a depth of 22 inches and yellowish-brown gravelly sand below.

Estherville soils have moderately rapid permeability in the loamy upper part and rapid or very rapid permeability in the underlying sand and gravel. They have very low or low available water capacity. The content of organic matter in the surface layer ranges from moderately low or very low. The content of available phosphorus is very low or low in the surface layer and very low in the subsoil. The content of available potassium is very low or low in the subsoil. The content of available potassium is very low or low in the surface layer and very low in the subsoil. Unless these soils are limed, reaction generally is medium acid or slightly acid in the surface layer.

Estherville soils are used mainly for permanent pasture and cultivated crops. The major limitations in cultivated areas are very low or low available water capacity and erosion.

Representative profile of Estherville sandy loam, 2 to 5 percent slopes, in a cultivated field 504 feet south and 810 feet east of the northwest corner of NE1/4 sec. 19, T. 90 N., R. 36 W.:

- Ap—0 to 8 inches, black (10YR 2/1) sandy loam; moderate, fine, granular structure; very friable; common roots; neutral; abrupt, smooth boundary.
- A12—8 to 13 inches, black (10YR 2/1) sandy loam; common peds of dark brown (10YR 3/3); weak, fine and medium, subangular blocky structure; very friable; common roots; few fine tubular pores; neutral; gradual, smooth boundary.
- B1—13 to 15 inches, very dark grayish-brown (10YR 3/2) sandy loam; common peds of dark brown (10YR 3/3) and brown (10YR 4/3); thin, discontinuous coatings of black (10YR 2/1) on peds; weak, fine and medium, subangular blocky structure; very friable; common roots; few fine tubular pores; neutral; gradual, smooth boundary.
- B2—15 to 19 inches, dark-brown (10YR 3/3) sandy loam; common, fine, faint mottles of brown (10YR 4/3); thin, discontinuous coatings of black (10YR 2/1) on peds; weak, fine and medium, subangular blocky structure; very friable; common roots; few fine tubular pores; neutral; clear, wavy boundary.
- IIC1—19 to 22 inches, dark yellowish-brown (10YR 4/4) gravelly sand; single grained; loose; few roots; slight effervescence; mildly alkaline; clear, smooth boundary.
- IIC2—22 to 32 inches, yellowish-brown (10YR 5/4) gravelly sand; single grained; loose; slight effervescence; moderately alkaline; clear, smooth boundary.
- IIC3—32 to 58 inches, yellowish-brown (10YR 5/4) gravelly sand; single grained; loose; slight effervescence; moderately alkaline; clear, smooth boundary.
- IIC4—58 to 72 inches, mixed yellowish-brown (10YR 5/4) and grayish-brown (10YR 5/2) gravelly sand; single grained; loose; slight effervescence; moderately alkaline.

Thickness of the solum generally is 15 to 24 inches. In places, however, it ranges to 30 inches. The A1 horizon is black (10YR 2/1), very dark brown (10YR 2/2), or very dark gray (10YR 3/1). The A

34B—Estherville sandy loam, 2 to 5 percent slopes.

This gently sloping soil is on convex ridges in glacial outwash areas, on stream terraces, and on small kames or knobs on glacial till uplands. Areas of this soil are irregular in shape and range from 4 to 10 acres in size.

This soil has the profile described as representative of the series. Included in mapping are areas of Salida soils and areas of soils that have a surface layer of loam.

Most areas of this soil are used for cultivated crops and pasture. The soil is moderately well suited to row crops. It is highly susceptible to both water erosion and soil blowing. The soil has low or very low available water capacity and does not have enough water available for satisfactory growth of crops in some years. The content of organic matter in the surface layer is moderately low or low. Capability unit IIIe-4; environmental planting group 4.

34C2—Estherville sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on convex ridges and slopes in glacial outwash areas, on stream terraces, and on small kames or knobs on glacial till uplands. Areas of this soil are long and narrow or irregular in shape and range from 4 to 10 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. Included in mapping are small areas of Salida soils.

Most areas of this soil are used for cultivated crops and pasture. The soil is moderately well suited to row crops. It is highly susceptible to both water erosion and soil blowing. The soil has low or very low available water capacity and does not have enough water available for satisfactory growth of crops in some years. The content of organic matter in the surface layer is low or very low. Capability unit IIIe-4; environmental planting group 4.

Everly Series

The Everly series consists of well-drained soils on uplands. These soils formed in loamy material that is about 20 to 30 inches thick and in the underlying Wisconsin (Tazewell) glacial till. The native vegetation was prairie grasses. Slopes are convex and range from 2 to 9 percent.

In a representative profile the surface layer is about 13 inches thick. It is very dark brown clay loam in the upper part and very dark grayish-brown clay loam in the lower part. The subsoil extends to a depth of 31 inches. It is brown, friable clay loam in the upper part and brown, friable loam in the lower part. The substratum is yellowish-brown loam.

Everly soils have moderate or moderately slow permeability and high available water capacity. The content of organic matter in the surface layer ranges from moderately low to high. The content of available phosphorus generally is low in the surface layer and very low in the subsoil. The content of available potassium is medium or high in the

A3—9 to 13 inches, very dark grayish-brown (10YR 3/2) clay loam; common, fine, faint mottles of dark brown (10YR 3/3) and brown (10YR 4/3); very dark brown (10YR 2/2) coatings on peds; weak, medium, subangular blocky structure parting to moderate, fine granular; friable; common roots; few very fine roots; tubular pores; slightly acid; clear, smooth boundary.

ately susceptible to erosion. The content of organic matter in the surface layer is moderate or high. Capability unit IIe-1; environmental planting group 1.

577C—Everly clay loam, 5 to 9 percent slopes. This moderately sloping soil is on convex side slopes. Areas of

surface layer and very low in the subsoil. The content of available potassium is medium or high in the surface layer and low in the subsoil. Unless these soils are limed, reaction generally is acid in the surface layer.

Galva soils are used mainly for cultivated crops. The major limitation in cultivated areas is erosion.

Representative profile of Galva silty clay loam, 2 to 5 percent slopes, in a cultivated field 144 feet north and 144

The B2 horizon is dark brown (10YR 3/3) or brown (10YR 4/3 or 10YR 5/3). Reaction is slightly acid or neutral.

The C horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4). Texture is light silty clay loam, silt loam, or clay loam. Reaction in the C horizon is moderately alkaline or mildly alkaline.

Galva soils are associated with Sac and Primghar soils. Unlike Sac soils, which formed in loess and the underlying glacial till, Galva soils formed entirely in loess. Galva soils have a browner B horizon and a slightly thinner A horizon than those of Primghar soils.

matter in the surface layer is high. Capability unit I-1; environmental planting group 1.

Gravel Pits

501—Gravel pits. This mapping unit consists of excavated areas on stream terraces and in glacial outwash areas that have or have had substantial deposits of sand and gravel. Individual areas are irregular in shape and range from 2 to 40 acres in size.

Many gravel pits are active and supply the sand and gravel needs of the county. Others have been abandoned either because all the sand and gravel has been excavated or because the remaining deposits of sand and gravel contain too many fine particles. Most of the abandoned gravel pits have been left open, and many are used as dumps for old farm machinery. In the low-lying areas many of the active gravel pits have water in the excavations. Many ponds in the county are abandoned gravel pits. A few of these are used for public parks and have areas for fishing, picnicking, and swimming. All these gravel pit areas are poorly suited to row crops. Capability unit VIIs-1; environmental planting group 4.

Harps Series

The Harps series consists of highly calcareous, poorly drained soils on till plains or outwash plains, generally on narrow rims of depressions. These soils formed in glacial till or glacial sediment under a native vegetation of swamp grasses, sedges, and prairie grasses that tolerate wetness. Slopes range from 0 to 2 percent.

In a representative profile the surface layer is black loam about 16 inches thick. The subsoil of friable loam extends to a depth of 35 inches. It is mixed dark gray and olive gray in the upper part, olive gray in the middle part, and light olive gray in the lower part. The substratum of loam is mixed olive gray and light olive gray to a depth of 50 inches, and light olive gray below.

Harps soils have moderate permeability and high available water capacity. The content of organic matter in the

carbonate; violent effervescence; moderately alkaline; gradual, smooth boundary.

B2gca—23 to 29 inches, olive-gray (5Y 5/2) loam, light olive gray (5Y 6/2) to light gray (5Y 7/2) when dry; common, fine and medium, faint mottles of dark gray (5Y 4/1) and light olive gray (5Y 6/2); weak, fine and medium, subangular blocky structure; friable; common roots; few fine tubular pores; few fine segregations of iron and manganese oxides; fine and medium segregations and concretions of calcium carbonate; violent effervescence; moderately alkaline; gradual, smooth boundary.

B3gca—29 to 35 inches, light olive-gray (5Y 6/2) loam; common, fine, faint mottles of pale olive (5Y 6/3); weak, medium, subangular blocky structure; friable; few roots; few fine tubular pores; few fine segregations of yellowish-brown (10YR 5/6 and 10YR 5/8), strong-brown (7.5YR 5/6), and very dark brown (10YR 2/2) iron and manganese oxides; common fine and medium segregations and concretions of calcium carbonate; violent effervescence; moderately alkaline; gradual, smooth boundary.

C1g—35 to 50 inches, mixed olive-gray (5Y 5/2) and light olive-gray (5Y 6/2) loam; common, fine, distinct mottles of pale olive (5Y 6/3); strong-brown (7.5Y 5/8) and very dark brown (10YR 2/2) iron and manganese oxides; massive; friable; common fine and medium concretions of calcium carbonate; violent effervescence; moderately alkaline; gradual, smooth boundary.

C2g—50 to 72 inches, light olive-gray (5Y 6/2) loam; common, fine and medium, faint and distinct mottles of gray (5Y 6/1), olive gray (5Y 5/2), dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6); massive; friable; few fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common fine and medium concretions of calcium carbonate; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 30 to 50 inches. The A1 or Ap horizon is black (10YR 2/1) or very dark gray (10YR 3/1). The A horizon is loam or light clay loam. The A1 horizon or the combined A1 and Ap horizons have a total thickness of 10 to 16 inches.

The B2 horizon ranges from gray (5Y 5/1 or 5Y 6/1) to grayish brown (2.5Y 5/2) or light brownish gray (2.5Y 6/2). The B horizon is loam, light clay loam, or sandy clay loam and is 14 to 36 inches thick. The C horizon has a range in color similar to that of the B2 horizon.

Harps soils, like the associated Canisteo soils, are calcareous. They have less clay in the solum and are more calcareous in the A horizon than those soils.

95—Harps loam, 0 to 2 percent slopes. This nearly level, highly calcareous soil is on narrow rims of depressions. Areas of this soil generally are long and narrow in

layer is high. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium ranges from very low to low in the surface layer and in the subsoil. Reaction is moderately alkaline in the surface layer.

Lanyon soils are used mainly for cultivated crops. The major limitations in cultivated areas are wetness and ponding.

Representative profile of Lanyon silty clay loam, 0 to 1 percent slopes, in a cultivated field 185 feet south and 130 feet east of the northwest corner of SW1/4 sec. 29, T. 93 N., R. 36 W.:

- Ap—0 to 7 inches, black (N 2/0) silty clay loam; moderate, fine, granular structure; friable; many roots; common fine fragments of snail shells; slight effervescence; moderately alkaline; abrupt, smooth boundary.
- A3—7 to 13 inches, black (N 2/0) heavy silty clay loam; common, fine and medium, distinct mottles of gray (5Y 6/1); weak, fine, subangular blocky structure parting to moderate, fine, granular; firm; common roots; common fine fragments of snail shells; slight effervescence; moderately alkaline; abrupt, wavy boundary.
- B2g—13 to 21 inches, olive-gray (5Y 5/2) silty clay; common, fine and medium, faint and distinct mottles of gray (5Y 5/1) and olive (5Y 5/4); weak, medium, prismatic structure parting to weak, fine, subangular blocky; firm, fine tubular pores; common fine root channels filled with black (N 2/0) and very dark gray (5Y 3/1) silty clay loam; common fine segregations of iron and manganese oxides; strong effervescence; moderately alkaline; gradual, smooth boundary.
- C1g—21 to 35 inches, mixed gray (5Y 5/1) and olive-gray (5Y 5/2) heavy silty clay loam; common, fine and medium, distinct mottles of light olive brown (2.5Y 5/4); weak, medium, prismatic structure; firm; common fine tubular pores; few fine root channels filled with very dark gray (5Y 3/1) silty clay loam; common fine segregations of iron and manganese oxides; common fine segregations of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.
- C2g—35 to 60 inches, mixed gray (5Y 5/1) and olive-gray (5Y 5/2) silty clay loam; common, fine and medium, distinct mottles of light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/6); massive; friable; common fine tubular pores; common fine and medium segregations of iron and manganese oxides; common fine segregations of calcium carbonate; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 10 to 24 inches. The A1 horizon is black (N 2/0 or 10YR 2/1). The A horizon is 8 to 16 inches thick. Reaction in the A horizon is mildly alkaline or moderately alkaline. This horizon is calcareous, and because of this is not within the defined range for the series. This difference, however, does not significantly

Lester Series

The Lester series consists of well-drained soils on convex side slopes, generally in wooded areas. These soils formed in glacial till under a native vegetation of grasses and trees. Slopes range from 18 to 40 percent.

In a representative profile the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is very dark grayish-brown loam about 2 inches thick. The subsoil extends to a depth of 31 inches. It is brown, friable to firm clay loam. The substratum is mixed yellowish-brown and grayish-brown clay loam to a depth of 40 inches and mixed light brownish-gray and yellowish-brown loam below.

Lester soils have moderate permeability and high available water capacity. The content of organic matter in the surface layer is low. The content of available phosphorus generally is very low or low in the surface layer and low or medium in the subsoil. The content of available potassium is low or medium in the surface layer and very low or low in the subsoil. Unless these soils are limed, reaction is medium and or slightly acid in the surface layer.

Lester soils are used mainly for woodland and woodland pasture. The major limitations for other land uses are steep or very steep slopes and a severe hazard of erosion.

Representative profile of Lester loam, 25 to 40 percent slopes, in a wooded area 400 feet south and 30 feet east of the northwest corner of sec. 23, T. 93 N., R. 38 W.:

- A1—0 to 7 inches, very dark gray (10YR 3/1) loam; moderate, medium and coarse, granular structure; friable; many roots; few fine tubular pores; common small pebbles; medium acid; clear, smooth boundary.
- A2—7 to 9 inches, very dark grayish-brown (10YR 3/2) loam; weak, medium, platy structure; friable; common roots; common fine tubular pores; common small pebbles; medium acid; clear, wavy boundary.
- B1t—9 to 13 inches, brown (10YR 4/3) clay loam; thick, continuous coatings of very dark grayish brown (10YR 3/2) on peds; moderate, fine and medium, subangular blocky structure; friable; common roots; common fine tubular pores; thin, discontinuous clay films of very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2); common small pebbles; medium acid; gradual, smooth boundary.
- B21t—13 to 20 inches, brown (10YR 4/3) clay loam; thin, discontinuous coatings of very dark grayish brown (10YR 3/2) on peds; moderate, fine and medium, subangular blocky structure; firm; common roots; common fine tubular pores; thin, discontinuous clay films of very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2); common small pebbles; medium acid; gradual, smooth boundary.

ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A horizon is loam or light clay loam. Reaction in the A horizon is medium acid or slightly acid. The A1 horizon is 6 to 10 inches thick. The A2 horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). It is loam or light clay loam and is 1 inch to 4 inches thick.

The B2 horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). Reaction in the B21 horizon ranges from slightly acid to strongly acid, and reaction in the B22 horizon ranges from medium acid to neutral.

Lester soils are associated with Clarion and Storden soils. They have a thinner A1 horizon than that of Clarion soils, and they generally have more clay in the B horizon. Lester soils have a thicker and much more acid solum than that of Storden soils.

236F—Lester loam, 18 to 25 percent slopes. This steep soil is on convex side slopes, generally in wooded areas. Areas of this soil are long and narrow and range from 5 to 40 or more acres in size.

Included with this soil in mapping are areas of soils that have a subsoil of heavy clay loam. Also included are small areas of Storden soils and small areas of Lester soils that have slopes of less than 18 percent.

Most areas of this soil are used for woodland and woodland pasture. The soil is poorly suited to row crops. It is very highly susceptible to erosion. Capability unit VIe-1; environmental planting group 1.

236G—Lester loam, 25 to 40 percent slopes. This very steep soil is on convex side slopes, generally in wooded areas. Areas of this soil are long and narrow and range from 5 to 40 or more acres in size.

This soil has the profile described as representative of the series. Included in mapping are areas of soils that have a subsoil of heavy clay loam. Also included are small areas of Storden soils.

Most areas of this soil are used for woodland and woodland pasture. The soil is not suited to row crops. It is very highly susceptible to erosion. Capability unit VIIe-1; en-

Ap—0 to 8 inches, black (N 2/0) heavy silty clay loam; weak, fine and medium, subangular blocky structure parting to moderate, fine and medium, granular; friable; many roots; slightly acid; clear, smooth boundary.

A12—8 to 14 inches, black (N 2/0) heavy silty clay loam; moderate, fine and medium, granular structure and weak, very fine, subangular blocky; friable; common roots; few very fine tubular pores; slightly acid; gradual, smooth boundary.

A3—14 to 17 inches, black (10YR 2/1) to very dark gray (10YR 3/1) heavy silty clay loam or light silty clay; common, fine, faint mottles of very dark grayish brown (2.5Y 3/2); moderate, very fine and fine, subangular blocky structure; friable; common roots; few very fine tubular pores; neutral; clear, smooth boundary.

B21g—17 to 21 inches, dark-gray (5Y 4/1) silty clay loam; few, fine, distinct mottles of yellowish brown (10YR 5/6); coatings of very dark gray (5Y 3/1) and black (10YR 2/1) on peds, very dark gray (5Y 3/1) when kneaded; moderate, very fine and fine, subangular blocky structure; friable; common roots; few very fine tubular pores; few fine segregations and concretions of yellowish-brown (10YR 5/6) and black (10YR 2/1) iron and manganese oxides; neutral; gradual, smooth boundary.

B22g—21 to 30 inches, dark-gray (5Y 4/1) silty clay loam; common, fine, faint and distinct mottles of olive gray (5Y 4/2), dark olive gray (5Y 3/2), and yellowish brown (10YR 5/6 and 10YR 5/8); thin, discontinuous coatings of black (10YR 2/1) and very dark gray (10YR 3/1) on peds in upper part and coatings of very dark gray (10YR 3/1) on peds in lower part; weak, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; few roots; common very fine and fine tubular pores; few fine segregations and concretions of yellowish-brown (10YR 5/6 and 10YR 5/8) and black (10YR 2/1) iron and manganese oxides; neutral; gradual, smooth boundary.

B23—30 to 38 inches, olive-gray (5Y 5/2) silty clay loam; common, fine distinct mottles of yellowish brown (10YR 5/6 and 10YR 5/8); weak, medium, prismatic structure parting to weak and moderate, fine and medium, subangular blocky; friable; few roots; common very fine and fine tubular pores; common fine segregations and concretions of yellowish-brown (10YR 5/6 and 10YR 5/8) and black (10YR 2/1) iron and manganese oxides; mildly alkaline; gradual, smooth boundary.

B3g—38 to 44 inches, olive-gray (5Y 5/2) silty clay loam; common, fine and medium, distinct mottles of olive brown (2.5Y 4/4), and

92—Marcus silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad flats or in narrow draws on uplands. Areas of this soil are irregular or long and narrow in shape and range from 4 to 50 or more acres in size.

Included with this soil in mapping are small areas of Afton and Primghar soils.

Most areas of this soil are cultivated. Where drainage is adequate, the soil is well suited to corn, soybeans, small grain, and alfalfa. It has a seasonal high water table. In cultivated areas it has a moderate limitation because of

A11b—35 to 40 inches, black (10YR 2/1) loam; weak, fine and medium, subangular blocky structure; friable; few roots; few fine tubular pores; slight effervescence; moderately alkaline; gradual, smooth boundary.

A12b—40 to 54 inches, black (10YR 2/1) loam; weak, fine and medium, subangular blocky structure; friable; few roots; few fine tubular pores; slight effervescence; moderately alkaline; gradual, smooth boundary.

A13b—54 to 63 inches, black (10YR 2/1) loam; weak, fine and medium, subangular blocky structure; friable; few fine tubular pores; slight effervescence; moderately alkaline; clear, smooth boundary.

A14b—63 to 72 inches, black (10YR 2/1) loam; weak, fine, subangular



Figure 13.—This wooded area on the Little Sioux River bottom is mainly Millington loam, channeled. Note the meandering channels through the scrub and brush timber. The wooded area across the road is frequently flooded, and the cultivated area across the river is on a stream terrace of mainly Wadena soils.

or medium in the surface layer and very low or low in the subsoil. Reaction is slightly acid or neutral in the surface layer.

Nicollet soils are used mainly for cultivated crops. During wet periods wetness is a slight limitation in cultivated areas.

Representative profile of Nicollet loam, 1 to 3 percent slopes, in a cultivated field 550 feet north and 70 feet west of the southeast corner of sec. 20, T. 91 N., R. 35 W.:

- Ap—0 to 8 inches, black (10YR 2/1) loam; weak, fine and medium, granular structure; friable; many roots; common fine tubular pores; common small pebbles; neutral; abrupt, smooth boundary.
- A12—8 to 16 inches, very dark gray (10YR 3/1) loam; coatings of black (10YR 2/1) on peds; weak, fine, subangular blocky structure parting to weak, fine and medium, granular; friable; common roots; common fine tubular pores; common small pebbles; neutral; gradual, smooth boundary.
- A3—16 to 20 inches, very dark gray (10YR 3/1) light clay loam; common fine peds of very dark grayish brown (10YR 3/2); thin, discontinuous coatings of black (10YR 2/1) on peds; weak, fine, subangular blocky structure parting to weak, fine, granular; friable; common roots; common fine tubular pores; common small pebbles; neutral; gradual, smooth boundary.
- B21—20 to 23 inches, mixed dark grayish-brown (2.5Y 4/2) and very dark grayish-brown (10YR 3/2) light clay loam; thin, discontinuous coatings of very dark gray (10YR 3/1) and black (10YR 2/1) on peds, dark grayish brown (2.5Y 4/2) when kneaded; weak, fine, subangular blocky structure; friable; common roots; common fine tubular pores; few fine segregations and concretions of yellowish-brown (10YR 5/6), brown (7.5YR 4/4), and very dark gray (10YR 3/1) iron and manganese oxides; common small pebbles; neutral; gradual, smooth boundary.
- B22—23 to 27 inches, dark grayish-brown (2.5Y 4/2) loam; few, fine, faint mottles of very dark grayish brown (2.5Y 3/2) and olive

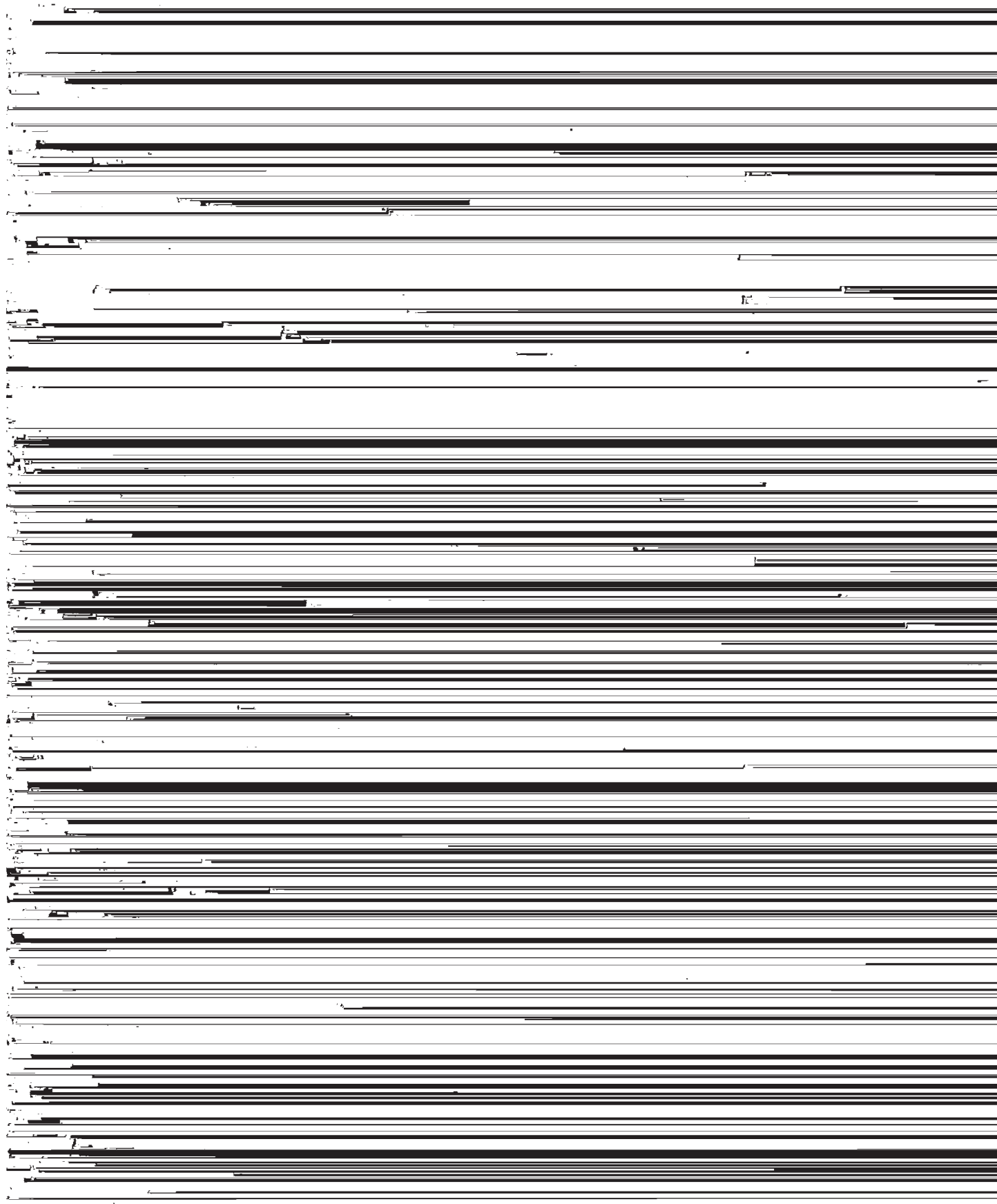
brown (2.5Y 4/4); thin, discontinuous coatings of very dark gray (10YR 3/1) on peds; weak, fine and medium, subangular blocky structure; friable; common roots; common fine tubular pores; few fine segregations and concretions of yellowish-brown (10YR 5/6), brown (7.5YR 4/4), and very dark gray (10YR 3/1) iron and manganese oxides; common small pebbles; neutral; gradual, smooth boundary.

- B23—27 to 34 inches, dark grayish-brown (2.5Y 4/2) loam; common, fine, faint mottles of olive brown (2.5Y 4/4); common, discontinuous coatings of very dark grayish brown (2.5Y 3/2) and very dark gray (10YR 3/1) on peds; weak, medium, subangular blocky structure; friable; few roots; common fine tubular pores; common fine and medium segregations and concretions of yellowish-brown (10YR 5/6), brown (7.5YR 4/4), and very dark gray (10YR 3/1) iron and manganese oxides; common small pebbles; neutral; clear, wavy boundary.

- C1—34 to 46 inches, grayish-brown (2.5Y 5/2) loam; common, fine, faint mottles of dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4); very weak, medium, subangular blocky structure; friable; few roots; common fine and medium segregations and concretions of yellowish-brown (10YR 5/6), brown (7.5YR 4/4), and very dark gray (10YR 3/1) iron and manganese oxides; common fine and medium segregations and concretions of calcium carbonate; common small pebbles; strong effervescence; moderately alkaline; gradual, smooth boundary.

- C2—46 to 60 inches, mixed light brownish-gray (2.5Y 6/2) and yellowish-brown (10YR 5/4) loam; common, fine and medium, faint and distinct mottles of grayish brown (2.5Y 5/2), yellowish brown (10YR 5/6), and brown (7.5YR 4/4); massive; friable; common fine tubular pores; common fine and medium segregations and concretions of yellowish-brown (10YR 5/6), brown (7.5YR 4/4), and very dark gray (10YR 3/1) iron and manganese oxides; common fine and medium segregations and concretions of calcium carbonate; common small pebbles; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 48 inches. The A horizon is black (10YR 2/1) or very dark gray (10YR 3/1). It is heavy loam, light clay loam, or silty clay loam and is 14 to 24 inches thick. Reaction is neutral or slightly acid.



soils that generally are on broad flats on uplands but are also in long, narrow, concave draws. Primghar soils formed in loess under a native vegetation of prairie grasses. Slopes range from 0 to 4 percent.

In a representative profile the surface layer is about 18 inches thick. It is black silty clay loam in the upper part and very dark grayish-brown silty clay loam in the lower part. The subsoil extends to a depth of 48 inches. It is dark grayish-brown, friable silty clay loam in the upper part and mixed dark grayish-brown and light olive-brown, friable silt loam in the lower part. The substratum is mixed dark grayish-brown and grayish-brown silt loam.

Primghar soils have moderate or moderately slow permeability and high available water capacity. The content of organic matter in the surface layer is high. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium is medium or high in the surface layer and very low or low in the subsoil. Unless these soils are limed, reaction generally is slightly acid or medium acid in the surface layer.

Primghar soils are used mainly for cultivated crops. The major limitation in cultivated areas is a slight wetness during wet periods.

Representative profile of Primghar silty clay loam, 0 to 2 percent slopes, in a cultivated field 1,520 feet north and 120 feet west of the southeast corner of NE1/4 sec. 5, T. 93 N., R. 38 W.:

Ap—0 to 7 inches, black (10YR 2/1) silty clay loam; moderate, fine, granular structure; friable; common roots; slightly acid; abrupt, smooth boundary.

A12—7 to 13 inches, black (10YR 2/1) silty clay loam; moderate, fine

subangular blocky structure; friable; few roots; common very fine and fine tubular pores; common fine segregations and concretions of iron and manganese oxides; neutral; gradual, smooth boundary.

C1—48 to 52 inches, mixed dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) silt loam; common, fine and medium, distinct mottles of dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6); massive; common very fine and fine tubular pores; common fine segregations and concretions of iron and manganese oxides; few fine and medium concretions of calcium carbonate; slight effervescence; mildly alkaline; gradual, smooth boundary.

C2—52 to 60 inches, mixed dark grayish brown (10YR 4/2) and grayish-brown (10YR 5/2) silt loam; common, fine and medium, distinct mottles of dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6); massive; common very fine and fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common fine and medium concretions of calcium carbonate; strong effervescence; moderately alkaline.

Thickness of the solum generally ranges from 30 to 50 inches. The A1 horizon is black (10YR 2/1 or N 2/0) or very dark brown (10YR 2/2). The A horizon is 16 to 22 inches thick. Reaction in the A horizon generally is slightly acid or medium acid.

The B2 horizon is dark grayish brown (10YR 4/2 or 2.5Y 4/2) or grayish brown (10YR 5/2 or 2.5Y 5/2). The B3 horizon is silty clay loam or silt loam. The B horizon is 14 to 32 inches thick. Reaction in the B horizon ranges from slightly acid to mildly alkaline except the B3 horizon is moderately alkaline in places.

The C1 horizon, if it is loess, is silt loam or light silty clay loam. Depth to the glacial till IIC horizon ranges from 40 to 96 inches or more.

Primghar soils are associated with Marcus, Galva, and Sac soils. They do not have the gleyed, gray B horizon that is characteristic of Marcus soils. They have a grayer B horizon than those of Galva and Sac soils. Unlike Sac soils, which formed in 24 to 36 inches of loess and the underlying glacial till, Primghar soils formed entirely in loess.

91—Primghar silty clay loam, 0 to 2 percent slopes.

silt loam about 8 inches thick. The subsoil extends to a depth of 47 inches. It is mixed very dark gray and olive-gray, firm silty clay in the upper part; olive-gray, firm heavy clay loam in the middle part; and olive-gray, friable loam in the lower part. The substratum is olive-gray loam.

Rolfe soils have slow permeability and high available water capacity. The content of organic matter in the surface layer is high. The content of available phosphorus is very low or low in the surface layer and very low in the subsoil. The content of available potassium ranges from very low to medium in the surface layer and is very low or low in the subsoil. Unless these soils are limed, reaction is medium acid or slightly acid in the surface layer.

Rolfe soils are used mainly for cultivated crops. The major limitations in cultivated areas are wetness and ponding.

Representative profile of Rolfe silt loam, 0 to 1 percent slopes, in a cultivated field 600 feet north and 189 feet west of the southeast corner of SW1/4 sec. 2, T. 93 N., R. 36 W.:

Ap—0 to 9 inches, black (10YR 2/1) heavy silt loam; moderate, fine, ~~granular structure; friable; many roots; slightly acid; abundant~~

soils. They have more clay in the B horizon than Okoboji soils and, unlike those soils, they have a gray A2 horizon.

274—Rolfe silt loam, 0 to 1 percent slopes. This soil is in shallow potholes and other depressions on the gently undulating glacial till plain. Areas of this soil are irregular in shape and generally range from 2 to 4 or more acres in size.

Included with this soil in mapping are areas of soils that have a substratum of silty clay loam.

Most areas of this soil are cultivated. The soil is moderately well suited to row crops. It is highly susceptible to ponding and generally has a high water table. In cultivated areas it has a severe limitation because of wetness. Capability unit IIIw-1; environmental planting group 2.

Sac Series

The Sac series consists of well-drained soils on uplands (fig. 14). These soils formed in loess that generally is 24 to



Figure 14.—Long, gentle and moderate slopes of Sac silty clay loam, loam substratum.



tinuous coatings of dark brown (10YR 3/3) on peds; weak, fine and medium, subangular blocky structure; friable; common roots; few fine tubular pores; neutral; gradual, smooth boundary.

IIB24—28 to 34 inches, brown (10YR 4/3) light clay loam; weak, fine and medium, subangular blocky structure; friable; common roots; few fine tubular pores; neutral; abrupt, wavy boundary.

IIB3—34 to 38 inches, yellowish-brown (10YR 5/6) loam; common, medium, distinct mottles of grayish brown (10YR 5/2), brown (10YR 4/3), and yellowish brown (10YR 5/4); weak, medium, subangular blocky structure; friable; few roots; few fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common small segregations and concretions of calcium carbonate; common small pebbles; mildly alkaline; abrupt, wavy boundary.

IIC1—38 to 58 inches, yellowish-brown (10YR 5/4) loam; common, medium, distinct mottles of strong brown (7.5YR 5/6), brown (10YR 5/3), dark yellowish brown (10YR 4/4), light brownish gray (10YR 6/2), and yellowish brown (10YR 5/6); massive; friable; few roots; few fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common small segregations and concretions of calcium carbonate; common small pebbles; strong effervescence; moderately alkaline; gradual, smooth boundary.

IIC2—58 to 70 inches, yellowish-brown (10YR 5/4) loam; common, medium, distinct mottles of light brownish gray (10YR 6/2), grayish brown (10YR 5/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6); massive; friable; few fine tubular pores; common fine segregations and concretions of iron and

B21—13 to 16 inches, dark-brown (10YR 3/3) silty clay loam; common, fine, faint mottles of brown (10YR 4/3); thin, discontinuous, very dark grayish-brown (10YR 3/2) and very dark gray (10YR 3/1) coatings on peds; moderate, fine and medium, subangular blocky structure; friable; common roots; common very fine and fine tubular pores; few, thin, discontinuous clay films of very dark grayish brown (10YR 3/2) on peds; neutral; gradual, smooth boundary.

R22—16 to 21 inches, brown (10YR 4/3) silty clay loam; thin, discon-

This soil has a profile similar to the one described as representative of the loam substratum phase of the Sac series, but the surface layer is a few inches thinner. Included in mapping are small areas of Everly and Storden soils. Also included are areas of soils that have slopes of more than 9 percent and areas of soils that are only slightly eroded.

Most areas of this soil are used for cultivated crops. The

Salida Series

The Salida series consists of excessively drained soils on small kames or knobs on uplands and on glacial outwash plains. These soils formed in calcareous, sandy and gravelly glacial deposits under a native vegetation of prairie grasses.

organic matter in the surface layer is low or very low. Capability unit IVs-1; environmental planting group 4.

73D—Salida gravelly sandy loam, 9 to 14 percent slopes. This strongly sloping soil is on small kames or knobs on glacial till plains and on glacial outwash stream terraces where slopes are convex. Areas of this soil are long and

B22g—28 to 34 inches, olive-gray (5Y 5/2) silty clay loam; common, fine and medium, faint and distinct mottles of light olive gray (5Y 6/2) and yellowish brown (10YR 5/6); thin, discontinuous coatings of very dark gray (5Y 3/1) on peds in upper part; weak, fine and medium, subangular blocky structure; friable; few roots; few fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common fine and medium segregations and concretions of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

B3g—34 to 41 inches, olive-gray (5Y 5/2) silty clay loam; many fine and medium, faint and distinct mottles of yellowish brown (10YR 5/6 and 10YR 5/8); weak, medium, subangular blocky structure; friable; few roots; few fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common fine and medium segregations and concretions of calcium carbonate; strong effervescence; moderately alkaline; gradual, smooth boundary.

C1g—41 to 54 inches, olive-gray (5Y 5/2) heavy silt loam; many, fine and medium, distinct and faint mottles of olive brown (2.5Y 4/4), yellowish brown (10YR 5/6), and light olive gray (5Y 6/2); massive; friable; few fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common fine and medium segregations and concretions of

Spillville soils have moderate permeability and high available water capacity. The content of organic matter in the surface layer is high. The content of available phosphorus generally is medium in the surface layer and low or medium in the underlying material. The content of available potassium generally is medium in the surface layer and low or medium in the underlying material. Reaction is neutral or slightly acid in the surface layer.

Spillville soils are used mainly for cultivated crops and pasture. The major limitations in cultivated areas are wetness and occasional flooding.

Representative profile of Spillville loam, 0 to 2 percent slopes, in a cultivated field 72 feet south and 207 feet west of the northeast corner of SE1/4 sec. 5, T. 93 N., R. 36 W.:

Ap—0 to 8 inches, black (10YR 2/1) loam; moderate, very fine and fine, granular structure; friable; many roots; common very fine and fine tubular pores; common very small pebbles; neutral; abrupt, smooth boundary.

A12—8 to 19 inches, black (10YR 2/1) loam; weak, very fine and fine, subangular blocky structure; friable; common roots; common

to row crops. It is very highly susceptible to erosion. The content of organic matter in the surface layer is very low or low. Capability unit VIIe-1; environmental planting group 3.

Talcot Series

The Talcot series consists of calcareous, very poorly drained soils on low-lying flats in glacial outwash areas on stream terraces. These soils formed in moderately fine textured glacial outwash underlain by sand and gravel at a depth of 24 to 40 inches. The native vegetation was swamp grasses and sedges and prairie grasses that tolerate wet-

mottles of olive gray (5Y 4/2); weak, fine and medium, subangular blocky structure; friable; common roots; common very fine and fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common fine segregations and concretions of calcium carbonate; common small pebbles; slight effervescence; moderately alkaline; gradual, smooth boundary.

B22g—28 to 36 inches, light olive-gray (5Y 5/2) loam; common, fine, faint mottles of olive gray (5Y 5/2); weak, fine and medium, subangular blocky structure; friable; few roots; common very fine and fine tubular pores; common fine segregations and concretions of iron and manganese oxides; common fine segregations and concretions of calcium carbonate; common small pebbles; slight effervescence; moderately alkaline; gradual, wavy boundary.

R3a—36 to 38 inches, light olive-gray (5Y 6/2) sandy loam; common

Most areas of this soil are cultivated. Where drainage is adequate, the soil is well suited to row crops. It has a seasonal high water table. The soil has low or moderate available water capacity and does not have enough water available for the best growth of crops in some years. In cultivated areas it has a moderate limitation because of wetness where it is artificially drained and a severe limitation because of wetness where it is not artificially drained. Capability unit IIw-3; environmental planting group 2.

Terril Series

The Terril series consists of moderately well drained soils on nearly plane to slightly concave foot slopes below nag-

neutral. The A1 horizon is black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). The A3 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2).

The B horizon is very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), or brown (10YR 4/3). It is loam, light clay loam, or silt loam. Reaction is slightly acid or neutral.

Terril soils, like Spillville and Colo soils, formed in colluvium or alluvium. Terril soils are browner within a depth of 36 inches than Spillville soils. They contain less clay and more sand than Colo soils and are better drained than those soils.

27C—Terril loam, 4 to 9 percent slopes. This moderately sloping soil is on nearly plane to slightly concave foot slopes. Areas of this soil are long and narrow and generally range from 4 to 20 or more acres in size.

Included with this soil in mapping are small areas of Spillville and Storden soils. Also included are small areas of

Q2 - Q4 to Q1 isobag cross (EV 5/1) silt loam: many medium distinct the sand and gravel and silt and clay

Areas of this soil are irregular in shape and range from 4 to 20 or more acres in size.

This soil has a profile similar to the one described as representative of the series, but depth to sand and gravel is 32 to 40 inches. Included in mapping are small areas of soils in which depth to sand and gravel is more than 40 inches.

Most areas of this soil are cultivated. The soil is well suited to row crops. It is moderately susceptible to erosion. It does not have enough water available for the best growth of crops in dry years. The content of organic matter in the surface layer is moderate. Capability unit IIe-1; environmental planting group 1.

108—Wadena loam, moderately deep, 0 to 2 percent

available for satisfactory growth of crops in many years. The content of organic matter in the surface layer is moderately low. Capability unit IIIe-3; environmental planting group 1.

Waldorf Series

The Waldorf series consists of poorly drained soils on low-lying ground moraines of the Wisconsin (Cary) till plain. These soils formed in fine-textured lacustrine sediment under a native vegetation of swamp grasses and sedges and prairie grasses that tolerate wetness. Slopes range from 0 to 2 percent.

In a representative profile the surface layer is black silty

pores; common, fine, strong-brown (7.5YR 5/6) and very dark brown (10YR 2/2) segregations and concretions of iron

granular; friable; common roots; common fine tubular pores; common small pebbles; neutral; gradual, smooth boundary.

A2 14 to 19 inches black (10YR 2/1) clay loam; few fine faint

Use and Management of the Soils

This section is designed to help the landowner understand how soils behave and how they can be used. In it are discussed the use and management of soils for crops and pasture, for wildlife and recreation, for environmental plantings, and for engineering.

Use of the Soils for Crops and Pasture

The soils in Buena Vista County are used mainly for corn, soybeans, oats, hay, and pasture. More than 90 percent of the county is cultivated.

The main considerations in managing cultivated soils in the county are controlling erosion, improving drainage, conserving moisture, and maintaining fertility.

Among the measures that help to control erosion are terracing, contour farming, diversions, waterways, and minimum tillage. Fall plowing of the soils subjects them to soil blowing, but this hazard can be reduced by various types of conservation tillage such as leaving a roughly plowed surface with alternating plowed and unplowed strips, or chisel plowing, which leaves crop residue on the surface.

Among the measures that help to improve drainage are tile drainage, open inlets, and surface drains.

Among the measures that help to conserve moisture are terracing, contour farming, and minimum tillage operations that leave crop residue on the surface. Any measure that reduces runoff generally increases infiltration and consequently conserves moisture.

Among the measures that help to maintain fertility are the application of chemical fertilizer, green manure, and barnyard manure, and the inclusion in the cropping system of cover crops, grasses, and legumes.

Tilth can be maintained by returning all crop residue, but an occasional year of meadow improves both tilth and fertility and helps to control weeds and insects.

Applications of fertilizer generally are beneficial on all crops, but the lime and fertilizer requirements of these soils vary considerably. Up-to-date information on soil testing and application of fertilizer can be obtained from the Soil

interpretations designed to show suitability and limitations of groups of soils for range, for woodland, or for engineering.

In the capability system (9), the kinds of soils are grouped at three levels; the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, and water supply or to esthetic purposes. (None in Buena Vista County.)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation. (In some soils the wetness can be readily con-

Arabic numeral specifically identifies the capability unit within each subclass.

In the following paragraphs the capability units in Buena Vista County are described and suggestions for the use and management of the soils are given.

Management by capability units

The capability units, or groups of soils that have similar management requirements, are described in the following paragraphs. Certain limitations of the soils are given in these descriptions, and suitable management is briefly discussed. To find the names of all soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of the survey. The groupings of soils shown in this guide are subject to change as new methods are discovered or new information becomes available.

CAPABILITY UNIT I-1

This unit consists of deep, nearly level, well-drained and somewhat poorly drained soils of the Galva, Nicollet, and Primghar series. The surface layer is loam or silty clay loam, and the subsoil also is loam or silty clay loam. Slopes range from 0 to 3 percent.

These soils have moderate or moderately slow permeability and high available water capacity. The content of organic matter in the surface layer is high. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium is medium or high in the surface layer of the Galva and Primghar soils, but it is low or medium in the surface layer of the Nicollet soils. The content of available potassium is very low or low in the subsoil of all of the soils in this unit. Reaction ranges from medium acid to neutral in the surface layer.

The soils of this unit are used mainly for cultivated crops. They are well suited to corn, soybeans, small grain, and alfalfa. Lime is needed on some of these soils. All the soils in this unit are friable and easy to work.

subsoil. Reaction is slightly acid or neutral in the surface layer.

This soil is used mainly for cultivated crops. It is well suited to row crops. Lime is needed in places. This soil is friable and easy to work. In dry years it is somewhat more susceptible to droughtiness than the soils in capability unit I-1.

Row crops can be grown on this soil much of the time. Fall plowing subjects the soil to soil blowing, but a roughly plowed surface with alternating plowed and unplowed strips reduces the hazard. Chisel plowing, which leaves all the crop residue on the surface, greatly reduces the hazard of soil blowing. An occasional year of meadow improves tilth and helps to control weeds and insects. Grassed waterways are needed in places for protection against erosion caused by runoff from higher areas.

CAPABILITY UNIT IIe-1

This unit consists of deep, gently sloping, well-drained soils of the Clarion, Everly, Galva, Sac, and Wadena series. The surface layer and the subsoil are loam, clay loam, or silty clay loam. Slopes range from 1 to 5 percent.

All but the Wadena soils in this unit have moderate or slow permeability and high available water capacity. Wadena soils have moderately rapid permeability and moderate available water capacity. The content of organic matter in the surface layer is moderate or high in soils of this unit. The content of available phosphorus generally is very low or low in the surface layer and subsoil. The content of available potassium is low or medium in the surface layer of the Clarion and Wadena soils and is medium or high in the surface layer of the Everly, Galva, and Sac soils. The content of available potassium is very low or low in the subsoil of all of these soils. Reaction ranges from medium acid to neutral in the surface layer.

The soils in this unit are used mainly for cultivated crops. They are well suited to corn, soybeans, small grain, and alfalfa. Lime is needed on many of these soils. These soils

tation and runoff. Interceptor tile is needed in places to remove seepage water and to allow more timely field operations.

CAPABILITY UNIT IIe-3

Wadena loam, moderately deep, 2 to 5 percent slopes, is the only soil in this capability unit. This gently sloping to gently undulating, well-drained soil is on convex ridges in glacial outwash areas and on stream terraces. The surface layer and subsoil are loam. The soil has sand and gravel at a depth of 24 to 32 inches.

This soil has moderately rapid permeability above the

Terraces are used in places to control erosion, but the many cuts required to build the terraces sometimes expose the clayey subsoil, which has poor fertility and poor tilth. Fertility and tilth generally can be only partly restored by spreading a layer of topsoil and large amounts of manure and crop residue over the cuts. Terraces help to conserve moisture in dry years, but in places they cause this slowly permeable soil to need tile drainage in the terrace channels in wet years. Because terraces have drawbacks on this slowly permeable soil, other erosion-control practices are generally used. These include fewer years of row crops in sequence with oats and meadow contour farming, and

and stream channel improvements can be used in some areas to help control flooding.

CAPABILITY UNIT IIw-2

This unit consists of deep, nearly level, poorly drained soils of the Afton, Canisteo, Marcus, Spicer, and Webster series. Slopes range from 0 to 2 percent. The surface layer

content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium ranges from very low to medium in the surface layer and is very low or low in the subsoil. The fertility of the Biscay soil generally is higher than that of the Talcot soils. Reaction generally is neutral in the surface layer of the Biscay soil and mildly alkaline or moderately alkaline in the surface layer of the Talcot soil.

An occasional year of meadow improves tilth and helps to control weeds and insects. Grassed waterways are needed in places for protection against erosion caused by runoff from higher areas. Tile drains function well in this soil. Tile drainage is important for corn and soybean production.

CAPABILITY UNIT IIw-5

Waldorf silty clay loam, 0 to 2 percent slopes, is the only soil in this capability unit. This nearly level, poorly drained soil is on low-lying ground moraines in the glacial till uplands. The surface layer is heavy silty clay loam, and the subsoil is silty clay.

This soil has moderately slow permeability and moderate available water capacity. Content of organic matter in the surface layer is high. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium ranges from very low to medium in the surface layer to very low or low in the subsoil. Reaction generally is neutral in the surface layer.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, small grain, and alfalfa. Lime is seldom needed. This poorly drained, slowly permeable soil has a clayey subsoil and is fairly difficult to work. It warms more slowly in spring than the poorly drained soils in capability units IIw-2 and IIw-3, and it dries more slowly after rains. If this soil is worked when wet, it becomes hard and cloddy when dry. Planting is delayed in years of heavy rainfall. The soil has a seasonal high water table, and it has a moderate limitation for crops because of wetness.

Row crops can be grown on this soil much of the time. They grow much better and the soil is easier to manage if adequate drainage is provided. Since wetness sometimes delays plowing in spring, this soil generally is plowed in fall. The fall plowing improves soil tilth by exposing the soil to freezing and thawing during fall and winter months. An occasional year of meadow improves tilth and helps control weeds and insects. Grassed waterways are needed in places to carry excess water caused by runoff from higher areas. Tile drains are only fairly effective in this slowly permeable soil, and adequate drainage is difficult to establish. For the most effective drainage, tile lines need to be spaced more closely in this soil than in most soils.

CAPABILITY UNIT IIw-1

Wadena loam, moderately deep, 0 to 2 percent slopes, is

Row crops can be grown on this soil much of the time. Such conservation practices as minimum tillage and contour farming, or both, are desirable in places and help to conserve moisture. Grassed waterways are needed in places for protection against erosion caused by runoff from higher areas. An occasional year of meadow improves tilth and helps to control weeds and insects. Fall plowing makes the soil susceptible to soil blowing, but a roughly plowed surface with alternating plowed and unplowed strips reduces the hazard. Chisel plowing, which leaves all the crop residue on the surface, greatly reduces the hazard of soil blowing and helps to conserve moisture.

CAPABILITY UNIT IIw-2

Cylinder loam, moderately deep, 0 to 2 percent slopes, is the only soil in this capability unit. This nearly level, somewhat poorly drained soil is in glacial till outwash areas and onstream terraces. The surface layer is loam, and the subsoil generally is loam. The soil has sand and gravel at a depth of 24 to 32 inches.

This soil has moderate permeability above the sand and gravel and rapid or very rapid permeability in the sand and gravel. It has moderate or low available water capacity. The content of organic matter in the surface layer is moderate or high. The content of available phosphorus generally is very low or low in the surface layer and very low in the subsoil. The content of available potassium generally is low or medium in the surface layer and is very low or low in the subsoil. Reaction generally is slightly acid or neutral in the surface layer.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, small grain, and alfalfa. Lime is needed in places. This soil is friable and easy to work, but it is moderately susceptible to droughtiness.

Row crops can be grown on this soil much of the time. Grassed waterways are needed in places for protection against erosion caused by runoff from higher areas. An occasional year of meadow improves tilth and helps to control weeds and insects. Fall plowing subjects the soils to soil blowing, but a roughly plowed surface with alternating plowed and unplowed strips reduces the hazard. Chisel plowing, which leaves all the crop residue on the surface, greatly reduces the hazard of soil blowing and helps to conserve moisture.

CAPABILITY UNIT IIw-3

Collinwood silty clay loam, 0 to 2 percent slopes, is the

Row crops can be grown on this soil much of the time. In wet years tile drains are beneficial in places. Since wetness sometimes delays field operations in spring, this soil generally is plowed in fall. Fall plowing improves soil tilth by exposing more of the soil to freezing and thawing action during fall and winter months. It also makes the soils more susceptible to soil blowing, but a roughly plowed surface with alternating plowed and unplowed strips reduces the hazard. Chisel plowing, which leaves all the crop residue on the surface, greatly reduces the hazard of soil blowing and helps to conserve moisture. Grassed waterways are needed in places for protection against erosion caused by runoff from higher areas. An occasional year of meadow also improves tilth and helps to control weeds and insects.

CAPABILITY UNIT IIIe-1

This unit consists of deep, moderately sloping, somewhat poorly drained to somewhat excessively drained soils of the Clarion, Collinwood, Everly, Galva, Sac, Storden, and Terril series. The surface layer is loam, clay loam, or silty clay loam. The subsoil or underlying material of most of these soils is loam, clay loam, or silty clay loam, but the subsoil of

to restore fertility and tilth to the exposed areas. In the Clarion, Galva, and Terril soils and in much of the Everly and Sac soils cuts generally do not expose calcareous material. Fertility and tilth generally can be restored to the subsoil cuts in a few years by spreading a layer of topsoil and large amounts of crop residue and manure over the exposed area. Depth to underlying calcareous, loamy material in the Clarion, Everly, and Sac soils generally ranges from 24 to 40 inches, and in the Storden soil it is less than 10 inches. Where cuts in building terraces expose this underlying calcareous material, tilth generally can be restored in a few years.

It takes many years, however, to restore or even partly restore fertility to the exposed calcareous areas in the Storden, Clarion, Everly, and Sac soils. Calcareous soils that have a low content of organic matter, such as the Storden soil, have very low fertility.

The combination of excess calcium and moderately alkaline reaction in the calcareous soils lowers the solubility and availability of phosphorus and promotes leaching of the soluble potassium. Additions of topsoil, crop residue, and manure are needed in the restoration process. Where cuts

friable and easy to work, but they are highly susceptible to erosion.

Such conservation practices as terracing, contour farming, and minimum tillage all help to control erosion. In places it is very difficult to build terraces on these soils because of the short, irregular slopes. Where cuts in building terraces expose the subsoil in the Clarion soil and the underlying material in the Storden soil, fertility and tilth can generally be restored in a few years by spreading a layer of topsoil and large amounts of crop residue and manure over the cuts. Extra effort is needed where calcareous material is exposed in the cuts. Grassed waterways are needed in places for protection against erosion caused by runoff from higher areas. When these soils are cultivated, adequate erosion-control practices are needed.

CAPABILITY UNIT IIIe-3

Wadena loam, moderately deep, 5 to 9 percent slopes, moderately eroded, is the only soil in this capability unit. This moderately sloping, well-drained soil is on convex ridges in glacial outwash areas and on stream terraces. The surface layer and subsoil are loam. The soil is underlain by sand and gravel at a depth of 24 to 32 inches.

This soil has moderately rapid permeability above the sand and gravel and rapid or very rapid permeability in the

These soils are used mainly for cultivated crops and pasture. They are only moderately well suited to row crops, but row crops can be grown much of the time if erosion is controlled. Many small areas of these soils are as intensively cultivated as the more productive soils surrounding them. Lime generally is needed periodically. Additions of fertilizer are beneficial on cultivated crops and forage, but large applications of fertilizer are not economical on these droughty soils. These soils warm early in spring, and they can be worked soon after a rain. These soils are friable and easy to work, but they are highly susceptible to droughtiness, soil blowing, and water erosion.

Such conservation practices as terracing, contour farming, and minimum tillage all help to control erosion and conserve moisture. Minimum tillage practices that leave crop residue on the surface greatly reduce the hazard of soil blowing. In building terraces, deep cuts should be avoided because exposing the underlying sand or sand and gravel would reduce the already low available water capacity and the productivity of these soils. In order to maintain the highest possible available water capacity, it is more desirable in places to use conservation practices other than terracing for erosion control. A cropping sequence that includes row crops, small grain, and meadow is also effective. Excess soil loss caused by soil blowing or water erosion can

of surface water. Tile drains are only fairly effective in these slowly permeable soils. In places tile outlets must be placed very deep, and in a few places suitable tile outlets are not available. An occasional year of meadow improves tilth and helps to control weeds and insects. Maintenance of a good drainage system on these soils is essential for intensive production of corn and soybeans.

CAPABILITY UNIT IIIw-2

This unit consists of very poorly drained, depressional

low in the surface layer and is very low in the underlying material. Reaction is moderately alkaline or mildly alkaline in the surface layer.

This soil is used mainly for pasture and cultivated crops. It is only moderately well suited to row crops, but they can be grown if erosion is controlled. This soil has an excess of lime. It generally is in good tilth and is easy to work, except in areas where the soil is severely eroded. In dry weather this soil is more droughty than less sloping Storden soils. This soil is highly susceptible to erosion.

CAPABILITY UNIT Vw-1

This unit consists of nearly level and gently sloping, poorly drained and somewhat poorly drained, channeled soils of the Colo, Millington, and Spillville series. These soils are on bottom lands that are dissected by many stream channels and are frequently flooded. Slopes range from 0 to 5 percent. The surface layer is silty clay loam in the Colo soils and loam in the Millington and Spillville soils. The

material is clay loam or loam. Slopes range from 18 to 25 percent.

These soils have moderate permeability and high available water capacity, but the amount of moisture absorbed is low because of rapid runoff on the steep slopes. The content of organic matter in the surface layer is low or very low. The content of available phosphorus is very low or low in the surface layer of the soils in this unit. The content of

phosphorus generally is very low or low in the surface layer and very low in the subsoil. Reaction generally is moderately alkaline in the surface layer.

This soil is used mainly for pasture and cultivated crops. It is poorly suited to row crops, but row crops can be grown if erosion is controlled. The areas of this soil generally are small. Most of them are used in the same manner as the surrounding soils. This soil generally has an excess content of lime. Applications of fertilizer are beneficial on forage and cultivated crops, but large applications of fertilizer are not economically feasible on this droughty soil. This soil is very friable and easy to work, but it generally has many rocks on the surface. It is highly susceptible to both water erosion and soil blowing.

Such conservation practices as contour farming and minimum tillage help to control erosion and conserve moisture. Minimum tillage practices that leave crop residue on the surface also greatly reduce the hazard of soil blowing. Cornucopia are not desirable on this shallow soil, because auto

prairie-grass pasture, but it is very difficult to apply fertilizer by farm machinery. The soils of this unit are very highly susceptible to erosion.

Controlled grazing and control of weeds and brush are needed on the permanent pasture to maintain a good stand of native prairie grasses such as big and little bluestem and side-oats grama. The areas most suitable for woodland management require protection from the grazing of livestock and the cutting of undesirable trees. The more desirable trees, as a result, will have more room for better growth without being damaged by livestock. For information on suitable trees for these soils, refer to the section "Use of the Soils for Environmental Plantings." The names of the specific soils in the unit and their environmental group numbers are given in the "Guide to Mapping Units" at the back of this publication.

CAPABILITY UNIT VIIw-1

Marsh is the only mapping unit in this capability unit.

TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*

[illegible]

IV - CAL - Soil - C - W - H - C - H - H - C

inches or less. The steep and very steep Lester soils often lack adequate available water, especially on south- and southwest-facing slopes. Also, cultural operations are limited by the topography of the Lester soils. The Spillville soils are subject to flooding, but generally the floods are infrequent and of short duration. The surface layer of most of the soils in this group is slightly acid or medium acid unless limed.

ENVIRONMENTAL PLANTING GROUP 2.—In this group are wet soils, and some that are subject to ponding or to flooding. Maximum duration of standing water is a few days to a week, except during unusually wet periods (Marsh is an

of the surface layer generally is slightly acid or neutral, but it ranges to moderately alkaline.

Only a small part of Buena Vista County is wooded. Most of the natural stands of trees are along the Little Sioux River (fig. 17). Trees and shrubs, however, have been planted around most farmsteads to serve as windbreaks. Few merchantable timber products have been produced in the county. Most of the woodland is grazed and is managed mainly for pasture.

Windbreaks are effective in reducing the severity of the climate around a farmstead. They also provide other benefits such as habitat for wildlife. Technical assistance in



TABLE 3.—*Environmental planting groups*

Environmental planting group	Type of planting	
	Shade tree	Street tree
<p>Group 1: Moderately coarse textured to moderately fine textured, somewhat poorly drained to somewhat excessively drained soils that have moderate or high available water capacity and are noncalcareous to a depth of at least 18 inches.</p>	American basswood, honey locust, green ash, hackberry, sugar maple, and silver maple.	Green ash, hackberry, pin oak, and sugar maple.
<p>Group 2: Medium textured or moderately fine textured, poorly drained or very poorly drained soils that have moderate or high available water capacity. Some of the soils are calcareous at or near the surface. Included</p>	Silver maple, hackberry, sycamore, and green ash.	Hackberry, American sycamore, and green ash.

of soils and suitable trees or shrubs

Type of planting—Continued			
Hedge or screen	Woodland	Windbreak	Wildlife
Lilac, American cranberrybush, Tatarian honeysuckle, silky dogwood, arrowwood viburnum, and hawthorn.	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, and poplars.	Eastern white pine, red pine, blue spruce, Norway spruce, Scotch pine, white spruce, European larch, eastern redcedar, green ash, hackberry, eastern cottonwood, Douglas-fir, Tatarian honeysuckle, Austrian pine, ponderosa pine, pin oak, Russian-olive, silver maple, and lilac.	Blackhaw, lilac, gray dogwood, alternate-leaf dogwood, autumn olive, Tatarian honeysuckle, American plum, and midwest Manchurian crabapple.
Northern white-cedar, silky dogwood, American cranberrybush, and Lombardy poplar.	Eastern cottonwood	Silver maple, poplars, laurel willow, American sycamore, green ash, hackberry ¹ , northern white-cedar, eastern redcedar ¹ , white spruce ¹ , and Norway spruce ¹ .	Red-osier dogwood, eastern redcedar, northern white-cedar, silky dogwood, and American cranberrybush.
Eastern redcedar, honeysuckle, Russian-olive, and Siberian peashrub.	Ponderosa pine, Austrian pine, Scotch pine, hackberry, poplars, and green ash.	Ponderosa pine, Austrian pine, green ash, hackberry, Russian-olive, eastern redcedar, and northern white-cedar.	American plum, Amur honeysuckle, Tatarian honeysuckle, Russian-olive, and eastern redcedar.
Eastern redcedar. Russian-olive.	Eastern white pine, Scotch pine,	Red pine, eastern white pine, Scotch	Blackhaw, lilac, gray dogwood,

typical profile of each soil series by layers sufficiently different from each other that each layer has unique significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for the specified soils and similar soils, and on experience with the same kinds of soils in other counties. In the following paragraphs are explanations of some of the columns in table 4.

Depth to seasonal high water table is the distance from the surface of the soil downward to the highest level reached in most years by ground water.

Soil texture is described in table 4 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Liquid limit and plasticity index pertain to the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to the plastic state, and the liquid limit from the plastic to the liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index in table 4 are estimates.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 4 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount in the soil at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume expected of soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soil causes much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material that has this rating.

Engineering interpretations of the soils

The estimated interpretations in table 5 are based on the engineering properties of soils shown in table 4, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Buena Vista County. In table 5, ratings are used

to summarize limitation or suitability of the soils for all listed purposes other than for drainage of cultivated areas and pasture, irrigation, pond reservoirs, embankments, and terraces and diversions. For those particular uses, table 5 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings *slight*, *moderate*, and *severe*. *Slight* means soil properties generally are favorable for the rated use or, in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable, but they can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation and special design is required. For some uses, the rating of severe is divided to obtain ratings of *severe* and *very severe*. *Very severe* means one or more soil properties is so unfavorable for the particular use that overcoming the limitations is too difficult and costly to be practical.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms *slight*, *moderate*, and *severe*.

The following paragraphs present explanations of some of the columns in table 5.

Septic-tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, content of organic matter, slope, and, if the floor needs to be leveled, depth to bedrock. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified Soil Classification, and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 5 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than 6 feet. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, for which soil ratings are given in

table 5, have an all-weather surface expected to carry automobile traffic all year. These roads and streets have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface that generally is asphalt or concrete. These roads and streets are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are of less than 6 feet.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity, stability of the subgrade, and workability and quantity of cut-and-fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet; for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings without basements, for which the soils are given limitation ratings in table 5, are those that are not more than three stories high and are supported by foundation footings placed in undisturbed soils. The features that affect the rating of a soil for such swellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of

the ratings is the damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or to other permeable material.

Embankments, dikes, and levees for retention of water require soil material that is resistant to seepage and piping and has favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or presence of organic material in a soil are among the unfavorable factors.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage or depth to water table or bedrock.

Terraces and drainageways are low ridges constructed across the slope to intercept or divert runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Special features affecting highway construction³

Some soils in the county have features that cannot be

TABLE 4.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The soils in referring to other series that appear in that column. Absence of data indicates that no

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	<i>Feet</i>	<i>Inches</i>			
Afton: 31 -----	1-3	0-30 30-46 46-60	Silty clay loam ----- Silty clay loam ----- Silty clay loam -----	OH or CH CH or CL CL or CH	A-7-6 or A-7-5 A-7-6 A-7-6 or A-6
Biscay: 259 -----	1-3	0-18 18-35 35-60	Clay loam ----- Clay loam or sandy clay loam ----- Sand and gravel -----	CL, OL, or OH CL SM-SW, SM or SC	A-7-6 A-6 A-1-b or A-2-4
Blue Earth: 511 -----	² 0-3	0-16 16-26 26-44 44-60	Mucky silt loam ----- Silty clay loam ----- Silt loam ----- Silt loam -----	OH or MH OH or CH CL CL	A-7-5 or A-7-6 A-7-6 or A-7-5 A-6 or A-7 A-6 or A-7
Calco: 733 -----	³ 1-3	0-36 36-60	Silty clay loam ----- Silty clay loam -----	OL or CH CL or CH	A-7-5 or A-7-6 A-7-6
Canisteo: 507 -----	1-3	0-23 23-34 34-60	Silty clay loam or clay loam ----- Clay loam ----- Clay loam -----	OH, CH, or MH CL CL	A-7-6 or A-7-5 A-6 or A-7-6 A-6 or A-7-6
Clarion: 138B, 138C2, 138D2 -----	>5	0-16 16-32 32-60	Loam ----- Loam ----- Loam or clay loam -----	CL or CL-ML CL or CL-ML CL or CL-ML	A-4 or A-6 A-4 or A-6 A-4 or A-6
250B -----	>5	0-11 11-44 44-60	Silty clay loam ----- Clay loam ----- Loam -----	ML or CL CL CL or CL-ML	A-7-5 or A-7-6 A-6 or A-7-6 A-6 or A-4
Collinwood: 384, 384B, 384C -----	2-4	0-15 15-37 37-60	Silty clay loam or silty clay ----- Silty clay ----- Silty clay -----	OH, MH, or CH CH or MH CH or MH	A-7-6 A-7-6 A-7-6
*Colo: 133, 585B, C585 ----- For Spillville parts of 585B and C585, see Spillville series.	³ 1-3	0-48 48-60	Silty clay loam ----- Silty clay loam -----	CL, OH, or OL CL or CH	A-7-6 A-7-6
Cylinder: 203 -----	2-4	0-16 16-36 ⁴ 36-60	Loam ----- Loam or sandy clay loam ----- Sand and gravel -----	CL CL or SC SP-SM, SC, or SM	A-6 or A-7-6 A-4 or A-6 A-1-b or A-2-4
202 -----	2-4	0-20 20-30 ⁵ 30-60	Loam ----- Loam or sandy clay loam ----- Sand and gravel -----	CL CL or SC SP-SM, SC, or SM	A-6 or A-7-5 A-4 or A-6 A-1-b or A-2-4
Dickinson: 175B -----	>5	0-13 13-25 ⁶ 25-39 39-60	Fine sandy loam ----- Fine sandy loam ----- Loamy fine sand ----- Fine sand -----	SM, SC, or SM-SC SM, SC, or SM-SC SM or SM-SC SM, SP, or SM-SP	A-4 or A-2-4 A-4 or A-2-4 A-2-4 A-2-4 or A-3
Ely: 428B -----	2-3	0-29 29-52 52-60	Silty clay loam ----- Silty clay loam ----- Silt loam -----	CL or OL CL CL	A-7-6 A-7-6 or A-6 A-6
Estherville: 34B, 34C2 -----	>5	0-13 13-19 ⁷ 19-60	Sandy loam ----- Sandy loam ----- Gravelly sand -----	SM, SM-SC, or SC SM, SM-SC, or SC SP, SM, or SC	A-2-4 A-2-4 A-1 or A-2-4
Everly: 577B, 577C, 577C2 -----	>5	0-13 13-31 31-60	Clay loam ----- Clay loam ----- Loam -----	ML or CL CL CL	A-6 or A-7-6 A-6 or A-7-6 A-6 or A-7-6
Fill land: 504 ----- Galva: 310, 310B, 310C2 -----	1-3 >5	0-60 0-16 16-48 48-60	(⁸) ----- Silty clay loam ----- Silty clay loam ----- Clay loam -----	(⁸) ML or CL ML or CL CL	(⁸) A-7-5 or A-7-6 A-7-6 A-6 or A-7-6
T310 -----	>5	0-17	Silty clay loam -----	ML or CL	A-7-5 or A-7-6

significant to engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for
~~estimating area made. The symbol > means greater than; the symbol < means less than.~~

TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	<i>Feet</i>	<i>Inches</i>			
		17-43	Silty clay loam -----	ML or CL	A-7-6
		43-50	Silt loam -----	CL	A-7-6 or A-6
		50-60	Gravelly sandy clay loam -----	CL, SC, or SM-SC	A-4 or A-6
		60-72	Gravelly fine sand -----	SM-SP, SM, or SC	A-1-b or A-2-4
Gravel pits: 501 -----	(⁸)	0-60	Gravel or sand -----	(⁸)	(⁸)
Harps: 95 -----	1-3	0-16	Loam -----	CL, CH, or OH	A-6, A-7-5, or A-7-6
		16-35	Loam -----	CL	A-6 or A-7-6
		35-60	Loam -----	CL	A-6 or A-7-6
Lanyon: 606 -----	² 0-3	0-13	Silty clay loam -----	OH or CH	A-7-6
		13-21	Silty clay -----	CH	A-7-6
		21-60	Silty clay loam -----	CH	A-7-6
				ML or CL	A-7-6 or A-6

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
	100	95-100	90-100	41-50	15-30	Inches per hour 0.6-2.0	pH 0.12-0.20	6.6-7.3	Moderate or high

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
100	95-100	75-90	70-85	41-55	15-25	0.6-2.0	0.17-0.19	7.4-8.4	Moderate or high.
95-100	90-100	70-85	55-75	35-50	15-25	0.6-2.0	0.16-0.18	7.9-8.4	Moderate.
75-95	60-80	20-45	5-20	NP-20	NP-6	6.0-20	0.02-0.04	7.9-8.4	Very low or none.
100	95-100	75-90	70-85	41-55	15-25	0.6-2.0	0.17-0.19	7.4-8.4	Moderate or high.
95-100	90-100	70-85	55-75	35-50	15-25	0.2-2.0	0.16-0.18	7.9-8.4	Moderate.
75-95	60-80	20-45	5-25	NP-20	NP-6	6.0-20	0.02-0.04	7.9-8.4	Very low or none.
100	95-100	70-90	60-80	25-40	5-15	0.6-2.0	0.18-0.20	6.1-7.3	Moderate.
100	95-100	70-90	60-80	25-40	5-15	0.6-2.0	0.17-0.19	6.1-7.3	Moderate.
---	100	90-100	80-95	45-70	20-35	0.6-2.0	0.23-0.25	6.1-7.3	Moderate.
100	95-100	85-100	75-95	41-60	20-35	0.2-2.0	0.21-0.23	6.1-7.3	Moderate or high.
95-100	90-100	80-90	60-85	30-40	15-25	0.6-2.0	0.20-0.22	7.4-8.4	Moderate.

TABLE 5.—*Interpretations of engineering*

[illegible]

[illegible]

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank ab- sorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings with- out basements
Clarion—Continued 250B -----	Slight -----	Moderate: slopes of 2 to 5 percent.	Slight ¹ -----	Slight -----	Slight: well drained; sea- sonal water table below a depth of 5 feet.	Slight: well drained.
Collinwood: 384 -----	Severe: slow permeability; seasonal high	Severe: seasonal high water table	Severe: some- what poorly drained; sea-	Severe: high shrink-swell potential; low	Severe: some- what poorly drained; sea-	Severe: low strength; high shrink-swell

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good-----	Unsuited: no sand or gravel.	Fair: moderate to high organic-matter content in surface layer; moderately fine texture.	Moderate permeability unless compacted; pockets of sand and gravel in places; slopes of 2 to 5 percent.	Good stability; stones or boulders in places; moderate shrink-swell potential.	Well drained; not needed.	High available water capacity; medium intake rate; slopes of 2 to 5 percent.	Features favorable; slopes of 2 to 5 percent.
Poor: low strength; high shrink-swell potential.	Unsuited: no sand or gravel.	Fair to poor: high organic-matter content in surface layer; fine texture.	Nearly level; slow permeability; seasonal high water table at a depth of 2 to 4 feet.	Fair stability; poor compaction; high shrink-swell potential.	Somewhat poorly drained; slow permeability; tile drains do not function well in places, but some areas benefit from tile drainage.	High available water capacity; slow intake rate; nearly level.	Not needed.
Poor: low strength; high shrink-swell potential.	Unsuited: no sand or gravel.	Fair to poor: fine texture; moderate to	Slow permeability; slopes of 2 to 5	Fair stability; poor compaction; high	Somewhat poorly drained; slopes of 2 to 5 percent.	High available water capacity; slow intake rate.	Clayey subsoil; difficult to estab-

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Cylinder: 203-----	Moderate: seasonal high water table at a depth of 2 to 4 feet; rapid permeability in substratum; hazard of contaminating ground water.	Severe: sand and gravel in substratum too porous to hold water; seasonal high water table at a depth of 2 to 4 feet; hazard of contaminating ground water.	Severe: rapid permeability in substratum; seasonal high water table at a depth of 2 to 4 feet; hazard of contaminating ground water.	Moderate: somewhat poorly drained.	Severe: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; sand and gravel at a depth of 32 to 40 inches.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.
202-----	Moderate: seasonal high water table at a depth of 2 to 4 feet; rapid permeability in	Severe: sand and gravel in substratum too porous to hold water; seasonal high water table	Severe: rapid permeability in substratum; seasonal high water table at a depth of 2 to 4	Moderate: somewhat poorly drained.	Severe: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet;	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair to good above a depth of 3 feet. Good below a depth of 3 feet: somewhat poorly drained.	Fair to poor: many areas contain considerable fines; seasonal high water table at a depth of 2 to 4 feet.	Good: medium texture; moderate to high organic-matter content in surface layer.	Porous sand and gravel substratum; nearly level; seasonal high water table at a depth of 2 to 4 feet.	Good stability, especially in substratum; pervious substratum.	Somewhat poorly drained; tile drains generally not needed; underlying sand and gravel hinder installation in places.	Moderate to high available water capacity; medium intake rate.	Not needed.
Fair to good above a depth of 2 to 2½ feet. Good below a depth of 2 to 2½ feet: somewhat poorly drained.	Fair to poor: many areas contain considerable fines; seasonal high water table at a depth of 2 to 4 feet.	Good: medium texture; moderate to high organic-matter content in surface layer.	Porous sand and gravel substratum; nearly level; seasonal high water table at a depth of 2 to 4 feet.	Good stability, especially in substratum; pervious substratum.	Somewhat poorly drained; tile drains generally not needed; underlying sand and gravel hinder installation in places.	Low to moderate available water capacity; medium intake rate; rapid permeability in substratum limits effective irrigation to a depth of 2 to 3 feet.	Not needed.
Good-----	Fair to poor: sand; many areas contain considerable fines.	Good to a depth of 1 to 1½ feet. Fair to poor below a depth of 1 to 1½ feet.	Rapid permeability in substratum; compaction or sealing material needed; too porous to hold water.	Fair stability; good workability and compaction; erodible; poor resistance to piping.	Somewhat excessively drained; not needed.	Low available water capacity; rapid intake rate; frequent irrigation needed; erodible.	Sandy substratum; difficult to establish plants in channels; erodible.
Poor: low strength; moderate to high shrink-swell potential.	Unsuited: no sand or gravel.	Good: high organic-matter content in thick surface layer.	Gentle slope; moderate permeability; seasonal high water table at a depth of 2 to 5 feet.	Adequate strength and stability; moderate to high shrink-swell potential.	Somewhat poorly drained; wetness because of seepage in places; interceptor tile needed.	High available water capacity; medium intake rate; slopes of 2 to 5 percent.	Features favorable; properly placed diversions help protect against overflow and siltation.
Good-----	Good to poor: many areas contain con-	Fair to a depth of 1 foot; coarse tex-	Sand and gravel at a depth of 15 to 30 inches;	Fair stability; good strength and compac-	Somewhat excessively drained; not needed.	Very low available water capacity; rapid intake rate;	Slopes generally short and irregular.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Everly: 577B -----	Slight -----	Moderate: slopes of 2 to 5 percent.	Slight ¹ -----	Slight -----	Slight: well drained; seasonal water table below a depth of 5 feet.	Slight: well drained.
577C, 577C2 -----	Slight -----	Severe: slopes of 5 to 9 percent.	Slight ¹ -----	Slight -----	Slight: well drained; seasonal water table below a depth of 5 feet.	Slight: well drained.
Fill land: 504 -----	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: very poorly drained to poorly drained; poor bearing capacity.	Very severe: very poorly drained to poorly drained; seasonal high water table at a depth of 0 to 3 feet.	Very severe: very poorly drained to poorly drained; seasonal high water table.
Galva: 310 -----	Slight -----	Moderate: moderate permeability; high organic-matter content in surface layer.	Slight ¹ -----	Moderate: moderate to high shrink-swell potential.	Slight: well drained; seasonal water table below a depth of 5 feet.	Moderate: moderate to high shrink-swell potential.
310B -----	Slight -----	Moderate: moderate permeability; moderate or high organic-matter content in surface layer; slopes of 2 to 5 percent.	Slight ¹ -----	Moderate: moderate to high shrink-swell potential.	Slight: well drained; seasonal water table below a depth of 5 feet.	Moderate: moderate to high shrink-swell potential.
310C2 -----	Slight -----	Severe: slopes	Slight ¹ -----	Moderate: mod-	Slight: well	Moderate:

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good-----	Unsuited: no sand or gravel.	Good: moderate to high organic-matter content in surface layer.	Gentle slope; moderate permeability; slow rate of seepage where compacted; pockets of sand and gravel in places.	Good stability; good for impervious cores where compacted; stones and boulders in places; moderate shrink-swell potential.	Well drained; not needed.	High available water capacity; medium intake rate; slopes of 2 to 5 percent; subject to rapid runoff; erodible.	Features favorable; stones and boulders in places; slopes of 2 to 5 percent.
Good-----	Unsuited: no sand or gravel.	Good: moderate to moderately low organic-matter content in surface layer.	Moderate slope; moderate permeability; slow rate of seepage where compacted; pockets of sand and gravel in places.	Good stability; stones and boulders in places; moderate shrink-swell potential.	Well drained; not needed.	High available water capacity; medium intake rate; slopes of 5 to 9 percent; subject to rapid runoff; erodible.	Features favorable; stones and boulders in places; slopes of 5 to 9 percent.
Very poor: poorly drained.	Unsuited: no sand or gravel.	Not applicable	Not applicable---	Not applicable---	Very poorly drained to poorly drained; seasonal high water table.	Not applicable---	Not needed.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Harps: 95 -----	Severe: seasonal high water table; adjacent to wet, depressional soils.	Severe: seasonal high water table; moderate to high organic-matter content in surface layer.	Severe: seasonal high water table; moderate permeability; adjacent to wet, depressional soils.	Severe: poorly drained.	Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet; adjacent to depressional soils.	Severe: poorly drained; seasonal high water table; adjacent to depressional soils; moderate to high shrink-swell potential.
Lanyon: 606 ----	Severe: subject to ponding; seasonal high water table; slow permeability.	Severe: subject to ponding; seasonal high water table; high organic-matter content in surface layer.	Severe: subject to ponding; seasonal high water table.	Severe: very poorly drained; subject to ponding; high shrink-swell potential.	Very severe: very poorly drained; seasonal high water table at a depth of 0 to 3 feet; subject to ponding; fine texture.	Very severe: very poorly drained; seasonal high water table; subject to ponding; high shrink-swell potential.
Lester: 236F -----	Severe: slopes of 18 to 25 percent.	Severe: slopes of 18 to 25 percent.	Severe: slopes of 18 to 25 percent. ¹	Severe: slopes of 18 to 25 percent.	Severe: slopes of 18 to 25 percent.	Severe: slopes of 18 to 25 percent.
236G -----	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Very severe: slopes of 25 to 40 percent.	Very severe: slopes of 25 to 40 percent.
Marcus: 92 -----	Severe: seasonal high water table; moderately slow permeability.	Severe: high organic-matter content to a depth of about 2 feet; seasonal high water table.	Severe: seasonal high water table.	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet.	Severe: poorly drained; seasonal high water table; high shrink-swell potential.
Marsh: 354 -----	Very severe: generally flooded.	Very severe: generally flooded.	Very severe: generally flooded.	Very severe: generally flooded; poor bearing capacity.	Very severe: generally flooded.	Very severe: generally flooded.
Millington: C458 ---	Severe: subject to frequent flooding; seasonal high water table.	Severe: subject to frequent flooding; seasonal high water table; high organic-matter content.	Severe: subject to frequent flooding; seasonal high water table.	Severe: poorly drained; subject to frequent flooding; high organic-matter content.	Very severe: poorly drained; seasonal high water table at a depth of 0 to 2 feet; subject to frequent flooding.	Very severe: poorly drained; seasonal high water table at a depth of 0 to 3 feet; subject to frequent flooding.
Nicollet: 55, 251 -	Severe: seasonal high water table at a depth of 2 to 4 feet.	Severe: high organic-matter content in surface layer; seasonal high water table at a depth	Severe: seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained.	Severe: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table; medium strength, mod-

[illegible]

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Okoboji: 6-----	Severe: seasonal high water table; subject to ponding on surface; slow permeability.	Severe: seasonal high water table; high organic-matter content in surface layer.	Severe: seasonal high water table; subject to ponding on surface.	Severe: very poorly drained; subject to ponding on surface; high shrink-swell potential.	Very severe: very poorly drained; frequent high water table at a depth of 0 to 3 feet; subject to ponding.	Very severe: very poorly drained; seasonal high water table; subject to ponding; high shrink-swell potential.
Primghar: 91---	Severe: seasonal high water table at a depth of 2 to 4 feet; moderate to moderately slow permeability.	Severe: moderate to moderately slow permeability; high organic-matter content in surface layer; seasonal high water table at a depth of 2 to 4 feet.	Severe: seasonal high water table at a depth of 2 to 4 feet.	Severe: high shrink-swell potential.	Severe: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table; medium strength; high shrink-swell potential.
91B-----	Severe: seasonal high water table at a depth of 2 to 4 feet; moderate to moderately slow permeability.	Severe: high organic-matter content in surface layer; seasonal high water table at a depth of 2 to 4 feet.	Severe: seasonal high water table at a depth of 2 to 4 feet.	Severe: high shrink-swell potential.	Severe: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table; high shrink-swell potential.
Rolfe: 274-----	Severe: frequent high water table; subject to ponding; slow permeability.	Severe: subject to ponding; frequent high water table; high organic-matter content in surface layer.	Severe: subject to ponding; seasonal high water table.	Severe: very poorly drained; high shrink-swell potential.	Very severe: very poorly drained; seasonal high water table at a depth of 0 to 3 feet; subject to ponding.	Very severe: very poorly drained; seasonal high water table; subject to ponding; moderate to high shrink-swell potential.
Sac: 77B-----	Slight: moderate permeability. ²	Moderate: slopes of 2 to 5 percent.	Slight ¹ -----	Moderate: moderate to high shrink-swell potential.	Slight: well drained; seasonal water table below a depth of 5 feet.	Slight: well drained; deep to water table.
77C2-----	Slight: moderate permeability. ²	Severe: slopes of 5 to 9 percent.	Slight ¹ -----	Moderate: moderate to high shrink-swell potential.	Slight: well drained; seasonal water table below a depth of 5 feet.	Slight: well drained; deep to water table.

[illegible]

TABLE 5 *Instrumentation of an irrigation*

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair in upper part. Good in underlying till.	Unsuited: no sand or gravel.	Fair to good: moderately fine texture.	Gentle slope; moderate permeability.	Poor stability to a depth of 2 to 3 feet; good stability below a depth of 3 feet; generally slow permeability where compacted; stones or boulders in places in underlying till.	Well drained; not needed.	High available water capacity; medium intake rate; slopes of 2 to 5 percent; subject to runoff and erosion.	Features favorable; slopes of 2 to 5 percent; good management practices needed to establish plants in channels.
Fair in upper part. Good in underlying till.	Unsuited: no sand or gravel.	Fair to good to a depth of 1 foot. Fair below a depth of 1 foot: moderately fine texture.	Moderate slope; moderate permeability.	Poor stability to a depth of 2 to 3 feet; good stability below a depth of 3 feet; generally slow permeability where compacted; stones or boulders in places in underlying till.	Well drained; not needed.	High available water capacity; medium intake rate; slopes of 5 to 9 percent; subject to runoff and erosion.	Features favorable; slopes of 5 to 9 percent; good management practices needed to establish plants in channels.
Good-----	Good to poor: many areas contain considerable fines.	Poor: low organic-matter content; gravelly.	Too porous to hold water.	Fair stability; good shear strength; good compaction; somewhat pervious layers; stones or boulders in places.	Excessively drained; not needed.	Very low available water capacity; rapid intake rate; rapid permeability; short, uneven slopes; subject to runoff and erosion.	Shallow to sand and gravel; difficult to establish plants in channels.
Good-----	Good to poor----	Poor: low organic-matter content; gravelly.	Too porous to hold water.	Fair stability; good shear strength; good compaction; somewhat pervious layers; stones or boulders in places.	Excessively drained; not needed.	Very low available water capacity; rapid intake rate; rapid permeability; short, uneven slopes; subject to runoff and erosion.	Shallow to sand and gravel; difficult to establish plants in channels.
Poor: poorly drained; high shrink-swell potential.	Unsuited: no sand or gravel.	Poor: poorly drained.	Nearly level; moderate permeability; seasonal high water table.	Fair stability; poor compaction; high compressibility; slow permeability.	Poorly drained; moderate permeability; seasonal high water table.	High available water capacity; medium to slow intake rate; seasonal	Not needed.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Spillville—Continued 485B -----	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table; high organic-matter content in surface layer.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding.	Severe: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; subject to flooding in places.	Moderate to severe: somewhat poorly drained; seasonal high water table; subject to flooding in places; fair bearing capacity and shear strength; coarse-textured strata in places below a depth of 4 feet.
Storden: 62C -----	Slight -----	Severe: slopes of 5 to 9 percent.	Slight ¹ -----	Slight -----	Slight: somewhat excessively drained; water table below a depth of 5 feet.	Slight: somewhat excessively drained; deep to water table.
62D -----	Severe: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.
62E -----	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent. ¹	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair: somewhat poorly drained; moderate shrink-swell potential.	Unsuited: no sand or gravel.	Good: high organic-matter content in thick surface layer; medium texture.	Gentle slope; moderate permeability; subject to flooding in places.	Fair stability; fair compaction below a depth of 2 to 3 feet; poor for embankment foundations.	Somewhat poorly drained; not needed in most places; subject to flooding in places.	High available water capacity; medium intake rate; subject to flooding in places.	Features favorable; properly placed diversions help protect against overflow and siltation.
Good-----	Unsuited: no sand or gravel.	Fair: low organic-matter content; calcareous.	Slopes of 5 to 9 percent; moderate permeability; pockets of sand or gravel in places.	Good stability; good compaction; slow permeability where compacted; stones or boulders in places.	Somewhat excessively drained; not needed.	High available water capacity; medium intake rate; limited by low fertility; slopes of 5 to 9 percent.	Short, irregular slopes in many places; good management practices needed to establish plants in channels; stones or boulders in places; slopes of 5 to 9 percent.
Good-----	Unsuited: no sand or gravel.	Fair: slopes of 9 to 14 percent; low organic-matter content; calcareous.	Slopes of 9 to 14 percent; moderate permeability; pockets of sand or gravel in places.	Good stability; good compaction; slow permeability where compacted; stones or boulders in places.	Well drained; not needed.	High available water capacity; medium intake rate; limited by low fertility; strong slopes of 9 to 14 percent.	Short, irregular slopes in many places; good management practices needed to establish plants in channels; stones or boulders in places; strong slopes of 9 to 14 percent.
Good-----	Unsuited: no sand or gravel.	Poor: slopes of 14 to 18 percent; low organic-matter content; calcareous.	Moderately steep slope; moderate permeability; pockets of sand or gravel in places.	Good stability; good compaction; slow permeability where compacted; stones or boulders in places.	Well drained; not needed.	High available water capacity; medium intake rate; limited by low fertility; moderately steep slopes of 14 to 18 percent.	Good management practices needed to establish plants in channels; stones or boulders

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Storden—Continued 62F -----	Severe: slopes of 18 to 25 per cent.	Severe: slopes of 18 to 25 per cent.	Severe: slopes of 18 to 25 per cent. ¹	Severe: slopes of 18 to 25 per cent.	Severe: slopes of 18 to 25 per cent.	Severe: slopes of 18 to 25 per cent.
62G -----	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 per cent. ¹	Severe: slopes of 25 to 40 percent.	Very severe: slopes of 25 to 40 percent.	Very severe: slopes of 25 to 40 percent.
Talcot: 559 -----	Severe: seasonal high water table; rapid permeability in substratum; hazard of contaminating ground water.	Severe: substratum too porous to hold water; hazard of contaminating ground water; seasonal high water table.	Severe: seasonal high water table; rapid permeability in substratum; hazard of contaminating ground water.	Severe: very poorly drained.	Severe: very poorly drained; seasonal high water table at a depth of 1 to 3 feet; sand and gravel at a depth of 32 to 40 inches.	Severe: very poorly drained; seasonal high water table; sand and gravel at a depth of 32 to 40 inches; moderate to high shrink-swell potential.
558 -----	Severe: seasonal high water table; rapid permeability in substratum; hazard of contaminating ground water.	Severe: substratum too porous to hold water; hazard of contaminating ground water; seasonal high water table.	Severe: seasonal high water table; rapid permeability in substratum; hazard of contaminating ground water.	Severe: very poorly drained.	Severe: very poorly drained; seasonal high water table at a depth of 1 to 3 feet; sand and gravel at a depth of 24 to 32 inches.	Severe: very poorly drained; seasonal high water table; sand and gravel at a depth of 24 to 32 inches; moderate to high shrink-swell potential.
Terril: 27C -----	Slight -----	Moderate: slopes of 4 to 9 percent; high organic-matter content; moderate permeability.	Slight ¹ -----	Moderate: moderate shrink-swell potential; high organic-matter content to a depth of 2 to 3 feet; subject to runoff from higher areas.	Moderate: moderately well drained; water table below a depth of 5 feet; subject to runoff from higher areas.	Moderate: subject to runoff from higher areas; moderate shrink-swell potential.
Wacousta: 506 -----	Severe: frequent high water table; subject to ponding on surface; moderate to moderately slow permeability.	Severe: high organic-matter content in surface layer; frequent high water table.	Severe: seasonal high water table; subject to ponding on surface.	Severe: very poorly drained; moderate to high shrink-swell potential.	Very severe: very poorly drained; frequent high water table at a depth of 0 to 3 feet; subject to ponding.	Very severe: very poorly drained; frequent high water table; subject to ponding; fair to poor bearing capacity.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Good-----	Unsuited: no sand or gravel.	Poor: slopes of 18 to 25 percent; low organic-matter content; calcareous.	Steep slope; moderate permeability; pockets of sand or gravel in places.	Good stability; good compaction; slow permeability where compacted; stones or boulders in places.	Well drained; not needed.	Unsuited: slopes of 18 to 25 percent.	Unsuited: slopes of 18 to 25 percent.
Good-----	Unsuited: no sand or gravel.	Poor: slopes of 25 to 40 percent; low organic-matter content; calcareous.	Very steep; moderate permeability; pockets of sand or gravel in places.	Good stability; good compaction; slow permeability where compacted; stones or boulders in places.	Well drained; not needed.	Unsuited: slopes of 25 to 40 percent.	Unsuited: slopes of 25 to 40 percent.
Poor: very poorly drained.	Fair to poor: many areas contain consid-	Poor: very poorly drained; sea-	Porous sand and gravel substratum;	High organic-matter content to a depth	Very poorly drained; seasonal high	Moderate to high available water capac-	Not needed.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Wadena: 308B -----	Slight: rapid permeability in substratum; hazard of contaminating ground water.	Severe: sand and gravel in substratum too porous to hold water; hazard of contaminating ground water.	Severe: rapid permeability in substratum; hazard of contaminating ground water.	Slight -----	Slight to moderate: well drained; water table below a depth of 5 feet; sand and gravel at a depth of 32 to 40 inches.	Slight: well drained; deep to water table; sand and gravel at a depth of 32 to 40 inches.
108 -----	Slight: rapid permeability in substratum; hazard of contaminating ground water.	Severe: sand and gravel in substratum too porous to hold water; hazard of contaminating ground water.	Severe: rapid permeability in substratum; hazard of contaminating ground water.	Slight -----	Slight to severe: well drained; water table below a depth of 5 feet; sand and gravel at a depth of 24 to 32 inches.	Slight: well drained; deep to water table; sand and gravel at a depth of 24 to 32 inches.
108B -----	Slight: rapid permeability in substratum; hazard of contaminating ground water.	Severe: sand and gravel in substratum too porous to hold water; hazard of contaminating ground water.	Severe: rapid permeability in substratum; hazard of contaminating ground water.	Slight -----	Slight to severe: well drained; water table below a depth of 5 feet; sand and gravel at a depth of 24 to 32 inches.	Slight: well drained; deep to water table; sand and gravel at a depth of 24 to 32 inches.
108C2 -----	Moderate: rapid permeability in substratum; hazard of contaminating ground water.	Severe: slopes of 5 to 9 percent; sand and gravel in substratum too porous to hold water; hazard of contaminating ground water.	Severe: rapid permeability in substratum; hazard of contaminating ground water.	Slight -----	Slight to severe: well drained; water table below a depth of 5 feet; sand and gravel at a depth of 24 to 32 inches.	Slight: well drained; deep to water table; sand and gravel at a depth of 24 to 32 inches.
Waldorf: 390 -----	Severe: moderately slow permeability; seasonal high water table.	Severe: high organic-matter content in surface layer; seasonal high water table.	Severe: seasonal high water table.	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet; fine texture.	Severe: poorly drained; seasonal high water table; high shrink-swell potential.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair to good above a depth of about 3 feet. Good below a depth of about 3 feet.	Good to poor: many areas contain considerable fines.	Good: moderate organic-matter content in surface layer; medium texture.	Gentle slope; porous sand and gravel substratum.	Good stability; substratum pervious where compacted.	Well drained; not needed.	Moderate to high available water capacity; medium intake rate; slopes of 1 to 5 percent.	Slopes generally short and irregular; sand and gravel below a depth of about 3 feet.
Fair to good above a depth of about 2 feet. Good below a depth of about 2 feet.	Good to poor: many areas contain considerable fines.	Good: high to moderate organic-matter content in surface layer; medium texture.	Nearly level; porous sand and gravel substratum.	Good stability; substratum pervious where compacted.	Well drained; not needed.	Low to moderate available water capacity; medium intake rate; rapid permeability in substratum limits effectiveness of irrigation to a depth of only 2 to 3 feet; nearly level.	Not needed.
Fair to good to a depth of about 2 feet. Good below a depth of about 2 feet.	Good to poor: many areas contain considerable fines.	Good: moderate organic-matter content in surface layer; medium texture.	Gentle slope; porous sand and gravel substratum.	Good stability; substratum pervious where compacted.	Well drained; not needed.	Low to moderate available water capacity; medium intake rate; rapid permeability in substratum limits effectiveness of irrigation to a depth of only 2 to 3 feet; gentle slopes of 2 to 5 percent.	Slopes generally short and irregular; sand and gravel below a depth of 2 to 2½ feet; slopes of 2 to 5 percent.
Fair to good to a depth of about 2 feet. Good below a depth of about 2 feet.	Good to poor: many areas contain considerable fines.	Good: moderate to moderately low organic-matter content in surface layer; medium texture.	Porous sand and gravel substratum; slopes of 5 to 9 percent.	Good stability; substratum pervious where compacted.	Well drained; not needed.	Low to moderate available water capacity; medium intake rate; rapid permeability in substratum limits effectiveness of irrigation to a depth of only 2 to 3 feet; slopes of 5 to 9 percent.	Slopes generally short and irregular; sand and gravel below a depth of 2 to 2½ feet; slopes of 5 to 9 percent.
Poor: poorly	Unsuited: no	Poor: poorly	Nearly level;	Fair stability;	Poorly drained;	High available	Not needed.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Shallow excavations	Dwellings without basements
Webster: 107-----	Severe: seasonal high water table; moderately slow to moderate permeability.	Severe: seasonal high water table; high organic-matter content in surface layer.	Severe: seasonal high water table.	Severe: poorly drained; moderate shrink-swell potential.	Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet.	Severe: poorly drained; seasonal high water table.

¹ Water table of these soils is at a depth of more than 5 feet.

² Permeability estimated to be 1.0–2.0 inches per hour (in the upper part of the moderate permeability class).

areas the density of the loess is fairly low in places, and the moisture content is high. The high moisture content causes instability of embankments where moisture is not carefully controlled at the time of compaction.

The soils that formed in loamy till, such as the Clarion, Nicollet, and Storden, range from loam to clay loam and are classified A-4 or A-6 and CL. Where these soils are in or adjacent to road grades, the material generally is placed in the upper part of the subgrade in areas that are unstable. Pockets and lenses of sand generally are interspersed throughout the till and generally are water bearing.

Where the road grade is only a few feet above the till the surface layer is silty, frost heaving is likely to occur unless the till is drained or the soil above the till is replaced with granular backfill or clayey till. Poorly drained soils that formed in glacial till and glacial sediment, such as these of the Webster series, are classified A-7 and OH to CL. In places these soils have high moisture content and low density.

be needed. If this is the case, backfilling with granular material may be desirable.

Formation and Classification of the Soils

The factors of soil formation are listed and discussed as they relate to the formation of soils in Buena Vista County in the first part of this section, the formation of horizons and the processes of their formation are discussed in the second part. The system of soil classification currently used is discussed in the third and last part, and each soil series of Buena Vista County is classified according to that system.

properties of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: poorly drained; moderate to high shrink-swell potential.	Unsuited: no sand or gravel.	Poor: poorly drained.	Nearly level; moderately slow permeability; seasonal high water table.	Fair stability and compaction below a depth of 1½ to 2 feet; slow permeability where compacted.	Poorly drained; seasonal high water table; moderate to moderately slow permeability; tile drains function well if outlets are adequate.	High available water capacity; medium intake rate; nearly level.	Not needed.

³ Permeability estimated to be 0.6–1.0 inch per hour (in the lower part of the moderate permeability class).

Parent material

The soils of Buena Vista County formed in glacial till, glacial outwash, loess, alluvium, eolian sand, and lacustrine sediment. The bedrock underlying these materials is so deep that it has had no influence on the formation of the soils.

Glacial outwash, or material deposited by melt water from glaciers, makes up extensive deposits of sand and gravel on benches along the Little Sioux and Raccoon Rivers. Similar deposits that are less extensive and shallow occur along other streams and near moraines in the central part of the county. The Biscay, Cylinder, Talcot, and Wadena soils formed in glacial outwash and overlie sand and

been three shifts in climate. These shifts were: a warming condition that produced a change from coniferous to deciduous trees, and gradual desiccation prior to the appearance of grasses, and continued drying that produced a climate more favorable to grasses. The recent work on climate by Walker

darker in these soils as the slope decreases. In like manner, the thickness of the solum increases from the thinner Storden soils to the thicker Clarion and Nicollet soils.

Time

The translocation of silicate clay minerals has contributed to the prominent horization in the Lester soils. The B horizon in these soils has more clay than the A horizon and often has dark-colored clay coatings on the ped surfaces and along root channels. The elluviated A2 horizon has platy structure, has less clay, and generally is lighter colored than the B horizon. The process of leaching of bases and translocation of clay in these soils have been more important in horizon differentiation than the accumulation of organic matter.

Horization is faintly expressed in the Harps and Canisteo soils. Carbonates have accumulated in the surface layer and subsoil. The calcium carbonate equivalent of the Harps soils is 10 to 40 percent.

Gleying, or the process of reduction and transfer of iron (8), is evident in the poorly drained and very poorly drained soils. The Afton, Biscay, Blue Earth, Calco, Canisteo, Colo, Harps, Marcus, Okoboji, Spicer, Wacousta, and Webster soils have a gleyed Bg horizon. This horizon is gray, which indicates the reduction and loss of iron. Some soils have

Entisols are light-colored soils that do not have natural genetic horizons or that have only very weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Mollisols formed under grass and have a thick, dark-colored surface horizon that contains colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike the Millisols, they lack a thick, dark-colored surface layer that contains colloids dominated by bivalent cations, but the base status of the lower horizons is not extremely low.

SUBORDER.—Each order is subdivided into suborders, mainly on the basis of the characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the cli-

TABLE 6.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Afton	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Haplaquolls	Mollisols.
Blue Earth	Fine-silty, mixed, calcareous, mesic	Cumulic Haplaquolls	Mollisols.
Calco	Fine-silty, mixed, calcareous, mesic	Cumulic Haplaquolls	Mollisols.
Canisteo	Fine-loamy, mixed, calcareous, mesic	Typic Haplaquolls	Mollisols.
Clarion	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Collinwood	Fine, montmorillonitic, mesic	Acric Hapludolls	Mollisols.

Lake watershed, which empties into Outlet Creek. Outlet Creek, in turn, empties into Raccoon River.

The Little Sioux River, which flows through the northern part of Lee, Barnes, and Brooke Townships drains more than 90,000 acres of Buena Vista County, mainly through the Brooke Creek watershed. Brooke Creek flows north to north-northwest through Washington Township, the southwestern corner of Scott Township, and Elk and Brooke Townships.

The Maple River in Cherokee County drains more than 30,000 acres of Buena Vista County through the Little Maple River in Maple Valley and Nokomis Townships, through Maple Creek in Brooke and Elk Townships, and through an unnamed creek in the northwestern part of Nokomis Township.

The Boyer River, through the Boyer River in Hayes and Maple Valley Townships and Boyer Creek in Hayes Township, drains more than 13,000 acres.

The Raccoon River watershed is part of the Mississippi River watershed area, and the Little Sioux, Maple, and Boyer River watersheds are part of the Missouri River watershed area.

Climate ⁴

Tables 7 and 8 present temperature, precipitation, and freeze data for Buena Vista County. Although these data were recorded at the weather station at Storm Lake, they generally are representative of most of the county.

On clear, calm nights, river valleys and areas that are relatively low compared to the surrounding areas may have minimum temperatures that are several degrees lower than those of upland or urban areas. Maximum temperatures do not vary so much, but extreme temperatures may be slightly less at Storm Lake. In an average year the number of days that have maximum temperatures of 90° or higher ranges from 16 days at Storm Lake to 26 days at Sioux Rapids. These temperatures are too high for optimum crop production, because water demand is excessive on those

10 in July and August. Well-developed crops use more than an inch of water a week during the summer.

The amount of moisture in the soil is an important factor in growth and survival of crops. A 5-inch reserve of available soil moisture is considered a critically low level in spring. In the southeastern part of the county there is about a 25-percent probability of having less than 5 inches of plant-available water present in the upper 5 feet of soil on April 15, but in the northwestern part this probability increases to 35 percent. The probability of having more than 9 inches available at this time is less than 20 percent.

Farming

Most of Buena Vista County is farmland. These farms are mainly used for corn, soybeans, oats, and hay, but they are also used for pasture. The principal livestock enterprises are raising hogs and feeding beef cattle. The acreage of each crop grown in 1971 and the number of each kind of livestock raised or fed in 1971 are listed below. The type and size of farms in the county in 1971 are also given. All of the data are from the Iowa Annual Farm Census (12).

Corn, soybeans, oats, and hay are the principal crops grown in Buena Vista County. Corn is grown on the largest acreage. Grain, especially corn and soybeans, is the main cash crop, but much of the corn and small grain are fed to hogs, cattle, and sheep on the farms.

The number of acres used for the principal crops and for pasture in 1971 are as follows:

Crops	Acres
Corn for all purposes	157,701
Oats for grain	12,546
Soybeans for beans	86,927
Sorghum	483
All hay	9,230
Pasture	28,385

Raising livestock, especially hogs, and fattening beef cattle are the main enterprises on many farms in the county. Farmers derive much of their income from the sale of these animals. The number of the principal kinds of

SOIL SURVEY

TABLE 7.—*Temperature and precipitation data*

[Data from weather station at Storm Lake]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly highest maximum	Average monthly lowest minimum	Average monthly total	One year in 10 will have—		Average number days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	Inches	Inches	Inches		Inches
January -----	27	8	46	-18	0.6	0.1	1.5	20	5
February -----	31	12	49	-11	.9	.1	2.2	18	4
March -----	41	22	67	-1	1.6	.5	3.4	14	6
April -----	59	36	79	20	2.4	1.0	4.3	1	2
May -----	71	48	86	31	4.0	1.1	6.6	---	---
June -----	80	58	91	43	4.9	1.9	8.9	---	---
July -----	86	63	95	50	3.9	1.3	6.7	---	---
August -----	83	61	93	47	3.5	1.3	5.8	---	---
September -----	76	52	88	33	2.9	.4	5.6	---	---
October -----	64	41	82	23	1.9	.1	4.6	(¹)	1
November -----	45	25	66	5	1.0	.1	2.7	3	3
December -----	32	14	52	-9	.7	.1	1.5	13	4
Year -----	58	37	96	-19	28.3	16.9	34.4	69	5

¹ Less than one-half day.TABLE 8.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data from weather station at Storm Lake]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than -----	April 15	April 22	April 30	May 12	May 21
2 years in 10 later than -----	April 9	April 16	April 25	May 7	May 16
5 years in 10 later than -----	March 30	April 5	April 14	April 27	May 6
Fall:					
1 year in 10 earlier than -----	October 26	October 18	October 12	September 25	September 22
2 years in 10 earlier than -----	October 31	October 23	October 18	September 30	September 28
5 years in 10 earlier than -----	November 11	November 3	October 29	October 11	October 8

Literature Cited

(1) American Association of State Highway (and Transportation) Offi-

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger.

mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A₂ horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner color than those in the A horizon, or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Shear strength. The resistance of a soil to stresses that cause or tend to cause parts of the soil to slide relative to each other in a direction parallel to their plane of contact.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the series to which it belongs. A technical description of a representative profile is part of the descriptive material for the soil series. In the section "Use and Management of the Soils," management for crops is discussed by capability units, environmental plantings are discussed, and information on use of the soils for wildlife habitat is presented.

Map symbol	Mapping unit	De- scribed on page	Capability unit		Environmental planting group
			Symbol	Page	Number
6	Okoboiji silty clay loam, 0 to 1 percent slopes-----	28	IIW-1	47	2
27C	Terril loam, 4 to 9 percent slopes-----	37	IIIe-1	46	1
31	Afton silty clay loam, 0 to 2 percent slopes-----	10	IW-2	44	2
32	Spicer silty clay loam, 0 to 2 percent slopes-----	34	IW-2	44	2
34B	Estherville sandy loam, 2 to 5 percent slopes-----	20	IIIe-4	47	4
34C2	Estherville sandy loam, 5 to 9 percent slopes, moderately eroded--	20	IIIe-4	47	4
55	Nicollet loam, 1 to 3 percent slopes-----	28	I-1	42	1
62C	Storden loam, 5 to 9 percent slopes-----	35	IIIe-1	46	3
62D	Storden loam, 9 to 14 percent slopes-----	35	IIIe-2	46	3
62E	Storden loam, 14 to 18 percent slopes-----	35	IVe-1	48	3
62F	Storden loam, 18 to 25 percent slopes-----	35	VIe-1	49	3
62G	Storden loam, 25 to 40 percent slopes-----	35	VIIe-1	50	3
73C	Salida gravelly sandy loam, 5 to 9 percent slopes-----	33	IVs-1	48	4
73D	Salida gravelly sandy loam, 9 to 14 percent slopes-----	33	VIs-1	49	4
77B	Sac silty clay loam, loam substratum, 2 to 5 percent slopes-----	32	IIe-1	42	1
77C2	Sac silty clay loam, loam substratum, 5 to 9 percent slopes, moderately eroded-----	32	IIIe-1	46	1
78B	Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes--	32	IIe-1	42	1
78C2	Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes, moderately eroded-----	32	IIIe-1	46	1
91	Primghar silty clay loam, 0 to 2 percent slopes-----	29	I-1	42	1
91B	Primghar silty clay loam, 2 to 4 percent slopes-----	29	IIe-2	42	1
92	Marcus silty clay loam, 0 to 2 percent slopes-----	26	IW-2	44	2
95	Harps loam, 0 to 2 percent slopes-----	23	IW-4	44	2
107	Webster silty clay loam, 0 to 2 percent slopes-----	40	IW-2	44	2
108	Wadena loam, moderately deep, 0 to 2 percent slopes-----	39	IIs-1	45	1
108B	Wadena loam, moderately deep, 2 to 5 percent slopes-----	39	IIe-3	43	1
108C2	Wadena loam, moderately deep, 5 to 9 percent slopes, moderately eroded-----	39	IIIe-3	47	1
133	Colo silty clay loam, 0 to 2 percent slopes-----	16	IW-1	43	2
138B	Clarion loam, 2 to 5 percent slopes-----	14	IIe-1	42	1
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded-----	14	IIIe-1	46	1
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded-----	14	IIIe-2	46	1
175B	Dickinson fine sandy loam, 2 to 5 percent slopes-----	19	IIIe-4	47	1
		19	IIe-2	45	1

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	De- scribed on page	Capability unit		Environmental planting group
			Symbol	Page	Number
C458	Millington loam, channeled, 0 to 2 percent slopes-----	26	Vw-1	49	2
485	Spillville loam, 0 to 2 percent slopes-----	34	IIw-1	43	1
485B	Spillville loam, 2 to 5 percent slopes-----	35	IIe-2	42	1
501	Gravel pits-----	23	VIIs-1	50	4
504	Fill land-----	21	Vw-2	49	2
506	Wacousta mucky silt loam, 0 to 1 percent slopes-----	38	IIIw-2	48	2
507	Canisteo silty clay loam, 0 to 2 percent slopes-----	13	IIw-2	44	2
511	Blue Earth mucky silt loam, 0 to 1 percent slopes-----	12	IIIw-2	48	2
558	Talcot clay loam, moderately deep, 0 to 2 percent slopes-----	36	IIw-3	44	2
559	Talcot clay loam, deep, 0 to 2 percent slopes-----	36	IIw-3	44	2
577B	Everly clay loam, 2 to 5 percent slopes-----	21	IIe-1	42	1
577C	Everly clay loam, 5 to 9 percent slopes-----	21	IIIe-1	46	1
577C2	Everly clay loam, 5 to 9 percent slopes, moderately eroded-----	21	IIIe-1	46	1
585B	Colo-Spillville complex, 2 to 5 percent slopes-----	16	IIw-1	43	2
C585	Colo-Spillville complex, channeled, 0 to 2 percent slopes-----	16	Vw-1	49	2
606	Lanyon silty clay loam, 0 to 1 percent slopes-----	24	IIIw-2	48	2
733	Calco silty clay loam, 0 to 2 percent slopes-----	12	IIw-1	43	2

U. S. DEPARTMENT OF AGRICULTURE

Washington, D. C. 20013

Soil Survey of Buena Vista County, Iowa

E R R A T U M

The descriptions for ad-hoc map symbols compiled on the detailed map sheets were inadvertently omitted from the Conventional and Special Symbols Legend of the soil survey publication.

Glacial till outcrop (< 2 acres)-----#
Moderately or highly calcareous spot (< 2 acres)----x
Small area of Okoboji soils (< 2 acres)-----o
Small hump of well drained soil (< 2 acres)-----#
Made land -----x
Small area of Rolfe silt loam -----o

This erratum should be inserted in each publication opposite the Conventional and Special Symbols Legend located at the beginning of the detailed map sheets of the soil survey publication.

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.